PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY

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PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION CXI.

Wednesday, 16th November 1881.—ROBERT ETHERIDGE, Jun., Esq., President, in the Chair.

The CHAIRMAN delivered the following opening address on

THE PALÆOZOIC CONCHOLOGY OF SCOTLAND.

GENTLEMEN,—Three years ago, when on the point of leaving Edinburgh, you did me the honour to elect me one of your Presidents, at the same time knowing that circumstances over which I had no direct control would prevent my fulfilling the ordinary and pleasant duties of the chair.

The Presidency of the Royal Physical Society of Edinburgh, in itself the oldest but one of the scientific bodies of the United Kingdom, has been filled by so many eminent men, known for their learning and culture in all branches of science, that I feel much diffidence in offering to you this evening the following remarks on "The Palæozoic Conchology of Scotland."

Before commencing the 111th Session a few words on the present condition of the Society may perhaps not be out of place. You will be pleased to hear that, on the whole, its state is satisfactory. I am glad to report that the Secretary is at present unacquainted with the death of any Fellow

during the interval since the Society last met. A material increase in the number of Fellows has, on the contrary, taken place. No less than twenty-nine elections were made during last session. The present strength is as follows:

Ordinary Fellows, ...	185
Non-Resident Fellows (Old), ...	51
Corresponding Fellows, ...	15
Honorary Fellows, ...	24

It is my duty, gentlemen, to earnestly call upon you to bring the merits of our Society before your friends, and to instil them with the objects for which we meet together. Only by this means can the strength of the Society be kept up and increased.

During the 110th and past Session a number of very important papers were read, and will shortly appear. Amongst them may be mentioned the following:

The address of the President, Professor J. Duns, D.D.—"The Early History of Scottish Natural Science," on November 17, 1880. This was followed at regular intervals by Dr Traquair "On the Affinities of Certain Liassic Fishes," Dr Herdman's "Additional Notes on the Invertebrate Fauna of Lamlash Bay," Mr Harvie-Brown "On the Distribution of the Squirrel in Great Britain," and Messrs Leslie and Herdman's very important summary of the "Invertebrate Fauna of the Firth of Forth." In the Botanical section my friend Mr R. Kidston read some very important notes "On the Structure of *Lepidodendron selaginoides*." It is not often that a species new to Britain is added; it was, therefore, with much pleasure that the Society must have listened to Mr J. J. Dalgleish's account of the "Occurrence of the Desert Wheatear" amongst us. To the pen of the Rev. O. P. Cambridge we are indebted for the description of a "New Species of Spider from Newfoundland," found by one of our Fellows, Mr Archibald Gray. I cannot conclude this brief summary of the Society's doings last session without referring to two other highly important papers, the first by Mr P. Geddes "On the Morphology of the Cell," and by Dr Herdman, "On the Olfactory Tubercle as a Specific Character in the Ascidians."

Palæontology, gentlemen, is a science which my friend and colleague, Dr R. H. Traquair, F.R.S., so aptly described to you two years since, as not at present occupying "a very exalted position in the estimation of the general public."* All the more reason, then, why we, who have made it, in its various branches, the study of our lives, should endeavour to disseminate that knowledge, and so elevate to the highest possible estate one of the most fascinating studies comprised within that very broad and comprehensive term, "Natural History."

The oldest writer on Scotch Palæontology, the Rev. David Ure, tells us that, "Extraneous or adventitious fossils are such as were originally organised bodies,"† whilst its most distinguished student, Thomas Davidson, Esq., F.R.S., of Davidson's Mains, and to whose writings frequent reference will be made, reminds us that "Scotland was long believed to be poor in organic remains."‡ To the works of this author, perhaps, as much as to any, we are indebted for the disproval of this very erroneous belief.

The subject of Fossil Conchology, of whatever area and geological period, is one possessing great and absorbing interest to the student of geological science. Of all life groups used by the geologist to assist him in working out the successive epochs of the earth's history, none, perhaps, have played so important a part, or yielded so satisfactory and valuable results, as the Mollusca. The remains of shells have existed from time immemorial. Their advent took place before the deposition of the earliest fossiliferous deposits of which we have any definite record. A corresponding advance in complexity and beauty of form has kept pace with successive geological periods.

Shells are not only of invaluable use to the geologist as a means, in conjunction with other divisions of the animal kingdom, of indicating life groups in the world's history, but they also afford a clue, within certain limits, to the climatical and bathymetrical conditions under which the rocks contain-

* Proc. Roy. Phys. Soc., Edinb., 1880, p. 140.

† History of Rutherglen and E. Kilbride, 1793, p. 295.

‡ Geologist, 1859, ii., p. 461.

ing their remains were deposited. More than this, the remains of molluscous animals, with those of plants and some reptiles, recall to us the former existence of many an old land surface.

The importance of the Mollusca has not been underrated by some of our best authorities. Professor Owen remarks—"The remains of the Testacea, or shell-bearing molluscous animals, are the most common of all fossils, and afford the most complete series of 'medals,' or characteristic signs, for the identification of strata."*

The late Dr Buckland observed—"Concurrent with the rapid extension of our knowledge of the comparative anatomy of extinct families of the ancient inhabitants of the earth has been the attention paid to Fossil Conchology, a subject of vast importance in investigating the records of the changes that have occurred upon the surface of the globe."

Again, Mantell observes—"The shells of Mollusca, from their durability, often escape obliteration under circumstances in which all traces of the higher order of animals are lost, and they become, therefore, of the utmost importance in the speculations of the geologist."

Lastly, the late Sir Charles Lyell, amongst his charming writings, remarked that, "Shells are by far the most important class of organic beings which have left their spoils in the subaqueous deposits, and they have been truly said to be the medals which Nature has chiefly selected to record the history of the former changes of the globe. There is scarcely any great series of strata that does not contain some marine or fresh-water shells."

This brief introduction will, I trust, Gentlemen, serve to indicate the importance of that branch of Palaeontology I have selected to bring before you this evening, under the title of "The Palaeozoic Conchology of Scotland." It would, doubtless, have been far more interesting and comprehensive to have treated of the "Fossil Conchology of Scotland," pure and simple. This, however, notwithstanding the enticing nature of the subject, would have led me beyond the time at my disposal, or [illegible] your patience.

* Palaeontology, [illegible]

"The Palæozoic Conchology of Scotland" conveniently subdivides itself into two sections—Silurian and Carboniferous. These will be treated of under separate headings, with a few remarks on the unimportant Devonian and Permian groups.

CONCHOLOGY OF THE SILURIAN ROCKS OF SCOTLAND.

The presence of fossils in the rocks composing the southern uplands, and other Silurian areas of Scotland, was little more than an undetected fact until a comparatively recent period. Organic rémains appear to have been first recorded from the rocks in question by the illustrious physicist, Dr James Hutton, in the year 1795.

Dr Hutton tells us in his great work, the "Theory of the Earth," * of the discovery by his friend and co-labourer, Sir James Hall, of "forms of cockles quite distinct, and in great abundance," in an "Alpine limestone," at Wrae hill, in the parish of Broughton, Peeblesshire.

We cannot pass over this, perhaps to the observers in question, apparently trivial circumstance, without pausing to reflect, that to a physicist we are indebted for the first discovery of life-traces in strata, afterward regarded by their successors in geological science as one of the palæontological landmarks of the old rocks of the southern uplands.

For about thirty-nine years these "forms of cockles" remained the sole representatives of palæontological science yielded by the strata in question. † It was not until the late Mr Charles Maclaren, for some time President of the Geological Society of Edinburgh, commenced his labours in the Pentland Hills, that we hear anything more of Scotch Silurian fossils.

In 1839 Maclaren published his classic little work, "A Sketch of the Geology of Fife and the Lothians," etc., ‡ in which he announced the interesting discovery of organic

* Theory of the Earth, 1795, vol. i., p. 335.

† I have left out of consideration the discovery of fossils by Laidlaw, the friend of Sir Walter Scott.

‡ 8vo, Edinburgh, 1839.

remains in the greywacke slate of the Pentland Hills. These were said to be of two kinds *—fragments of what seem to be minute Trilobites, associated in thin layers, and another fossil, believed by Dr Hibbert to be an *Orthoceratite,* and of which a figure is given. † Two of these precious relics afterwards passed into the possession of the late Hugh Miller. One of the *Orthoceratites,* we are told by the latter author, ‡ bore on its label the date of discovery, "7th April 1834," which would leave an interval of about thirty-nine years after the "Cockles" of Sir James Hall first came to light.

A short period of inactivity intervened now, and nothing more is heard of fossils from the Silurian rocks of Scotland until 1843. In this year the celebrated engineer, Thomas Stevenson, whilst superintending the erection of a lighthouse on the island of Little Ross in Kirkcudbright Bay, observed shells in a coarse greywacke there. His paper, giving a description of the geological features of the island, entitled "Remarks on the Geology of Little Ross," was read before the Wernerian Natural History Society on the 8th April 1843. § The shells, he tells us, "appear to belong to the genus Terebratula;" and he further announced the discovery by Mr E. G. Fleming of an *Orthoceras* in similar rocks on the mainland of the bay, opposite the island.

From this time forward the gathering of fossils from the southern uplands may be said to have commenced in earnest. In 1844 Professor James Nicol gave a list of organic remains in his "Guide to the Geology of Scotland." ‖ Those only with which we are at present concerned were derived from the strata of Girvan, seven species in all, comprising one Sponge, three Brachiopods, and one Pteropod. This is, I believe, the first record of fossils from that now well-explored neighbourhood, a district which has since proved the most fossiliferous Silurian locality in Scotland, and one of the most interesting in the whole of the British Islands.

The name of an observer now appears for the first time in

* A Sketch of the Geology of Fife and the Lothians, etc., p. 203.

† *Ibid.*, p. 203, f. 82. ‡ Old Red Sandstone, 7th edit., 1859, p. 297.

§ Edinb. N. Phil. Jour., 1843, xxxv., p. 83.

‖ 8vo, Edinburgh, 1844, p. 261.

Scotch Palæontology, to whom, perhaps, more than to any other, we are indebted for our early lessons in that subject. I refer to the late John William Salter, for many years Palæontologist to Her Majesty's Geological Survey of Great Britain. I may, perhaps, be pardoned if I make a slight digression here to say a few words on Salter's work. An apology is, I think, hardly necessary when we recollect how intimately his name was at one time associated with that of his patron, the late Sir R. I. Murchison, K.C.B., F.R.S., in all matters relating to Scotch geology, wherein organic remains claimed attention. My deceased friend and instructor was at the same time a palæontologist, an artist, an engraver, and a fine entomologist. In fact, whatever subject was brought forward for discussion, whether in science or general literature, Salter was equally at home in it. His greatest distinction was undoubtedly won in Silurian Palæontology, a branch he especially made his own, paying particular attention to the Crustacea and Mollusca. His efforts in this direction were greatly aided by a most facile pencil, whether on stone, the blackboard, metal, or in the note-book, enabling him to portray with the greatest accuracy the forms he loved so well to decipher. To him we are indebted for the earliest descriptions of the fossils of the Girvan areas, the north-west Highlands, and the Pentland Hills.

The first Silurian fossils from Scotland, published by Salter, were derived from the collection of the Earl of Selkirk, obtained at St Mary's Isle, Kirkcudbright Bay, from rocks forming a continuation of the Lammermoor range.* These possess great interest to the palæontologist from their intimate connection with those found by Messrs Stevenson and Fleming in the same neighbourhood. Eleven species of shells were determined from his Lordship's collection, including four Brachiopods, the same number of Univalves, two Bivalves, and one Cephalopod. Salter believed the strata yielding these fossils to be about the age of the Wenlock shale of the West of England.

The "old forms of cockles" of Wrae quarry next claimed Salter's attention, and we are now able to quote the scientific

* Quart. Jour. Geol. Soc., 1847, iv., p. 206.

but high sounding names of these ancient "buckies." In a collection made by Professor James Nicol and noticed in his paper "On the Geology of the Silurian Rocks in the valley of the Tweed,"* Mr Salter detected six species of shells, irrespective of other organisms from that locality,† viz.:—

Leptæna tenuistriata, *Sby.*
Orbicula, sp.
Orthis calligramma, *Dalman.*
Orthis (large sp.).
Spirifera biforata, *Schlotheim*, var.
Lituites cornuarietis, *Sby.*

Such are some of the "cockles" from Sir James Hall's "Alpine limestone," a bed, Professor Nicol tells us, 30 feet in thickness, and now known as the Wrae limestone.

Many years after, this list was enlarged by the addition of two other shells — *Orthis actoniæ*, and *Orthoceras ibex* (Salter).‡

Salter's investigations were continued in the next year, as we learn from the title of a short paper, "Note on the Fossils from the Stinchar River, and the Slates of Loch Ryan," § appended to a communication by Mr J. Carrick Moore, "On some Fossiliferous Beds in the Silurian Rocks of Wigtownshire and Ayrshire," who discovered the fossils. The red slate of Loch Ryan yielded a single univalve, the *Euomphalus furcatus* (M'Coy), accompanied by Graptolites. The Stinchar bed, a limestone, probably identical with that at Wrae quarry, and like it about 30 feet in thickness, yielded six species of Gasteropoda and one Brachiopod. Salter remarked, however, that at Wrae the latter are the characteristic fossils, whilst in the Stinchar limestone the spiral shells are the commonest.

In 1851 appeared the most important contributions to Scotch Silurian Palæontology published up to that date—a

* Quart. Jour. Geol. Soc., 1848, v., pp. 195-209.

† "Notice of the fossils collected by Mr Nicol in Peeblesshire" (*Ibid.*, v., pp. 205, 206).

‡ Mem. Geol. Survey, Scotl., 1869, Expl. xxiv., p. 8.

§ Quart. Jour. Geol. Soc., 1849, v., p. 13.

"List of some of the Silurian Fossils of Ayrshire,"* appended to Murchison's memoir, "On the Silurian Rocks of the South of Scotland."†

About, and previous to the year 1850, Murchison had traversed the larger portion of the area in question, accompanied by Professor J. Nicol. Around Girvan his researches were assisted by the local knowledge of Alexander Maccallum, a resident, who combined the avocation of a weaver with the pastime of fossil collecting. A friend, who knew the neighbourhood of Girvan well in these early days, has afforded me the following information about Maccallum:—He was the first person who collected in the neighbourhood, and often laid aside his work to gratify his liking for rambling over the country in search of curiosities. After he became known he acted as guide to geologists visiting Girvan, and in this capacity became acquainted with Sedgwick, Murchison, and Hugh Miller. He was, besides a weaver and fossil collector, a fiddler at country dances. He died in 1854, aged fifty-one. Maccallum managed to gather a goodly number of fossils, the majority of which were shells. These, after due comparison with kindred collections from Wales, were determined by Salter, to the number of thirty-seven species. The evidence afforded principally by these fossils enabled Sir Roderick Murchison to lay down the first rough classification of the Silurian rocks of Girvan. Glancing at the list, the first important point which strikes us is the general absence of Mollusca of truly Upper Silurian age, and the prevalence of forms of a decidedly Middle Silurian type. The 37 species comprised 17 Brachiopods, 1 Bivalve, 13 Univalves, and 6 Cephalopods, or chambered shells.

We observe, for the first time in palæontological annals, the record of that characteristic and important Llandovery shell *Pentamerus*, in the conglomerate of Cuddystone Glen, and the shelly sandstone of Mulloch Hill. Amongst the other Brachiopods which may be referred to as interesting are a *Terebratula*,‡ in the Craighead limestone, probably identical with a Canadian species; another American form, *Orbicula*

[illegible] 170-178. † *Ibid.*, pp. 139-169.

crassa (Hall), in the flagstones of Knockdolian and Ardwell, a characteristic species of the Utica slate of New York. Again, a group of shells well marked in American Silurian rocks are the *Pleurorhynchi*, represented in the Craighead limestone by the *P. dipterus* (Salter), and peculiar to that deposit.

The univalve shells again indicate the singular coincidence existing between many of the Girvan species and those of the Silurian deposits of North America. We have, for instance, *Murchisonia angustata* (Hall), in the Cuddystone conglomerate, a fossil of the Bird's-eye limestone of the Trenton group. By no means the least interesting of the organic remains from Girvan is the curious genus *Maclurea*, with its abnormal operculum or mouthpiece, represented by no less than three species. These occur low in the series, in the Craighead, or Aldons limestone, and at several localities.

In America *Maclurea* is characteristic of the Lower Silurian series almost entirely. It is supposed to have belonged to that division of the Mollusca termed Heteropoda, or Nucleo-branchiata, in which the foot is modified to act as a swimming organ, and in which the respiratory organs are confined to a nucleus placed on the hinder part of the back. Another genus of the same order well represented in Girvan rocks is *Bellerophon*, in which the shell is symmetrical and convoluted, and the whorls in one plane. Salter determined four species in the Girvan rocks.

Lastly, those strange chambered shells, the *Orthoceratites*, are represented by five or six species. They occur high in the series in the Orthoceratite flags of Piedmont Glen, Ardwell, etc., above the shelly sandstone of Mulloch. According to M. Barrande the *O. politum* (M'Coy) from Piedmont Glen is identical with a species from the lower part of the Bohemian Upper Silurian.

Contemporary with Salter's work on the Girvan fossils were the researches of a brother palæontologist, Mr Frederick M'Coy, then assistant to the late Professor Sedgwick, now Professor of Natural Science in the University of Melbourne. Although not of the same extent, or depth of investigation

as Salter's, M'Coy's work has left its mark on Scotch Silurian Palæontology. The material employed by him was chiefly collected by Professor Sedgwick during a tour in the Border counties of Scotland in 1841, and again in 1848. The scientific results of this trip were communicated to the British Association in 1850, and entitled, "On the Geological Structure and Relation of the Frontier Chain of Scotland."* The list of organic remains prepared by Professor M'Coy was appended, and does not differ materially, allowing for discrepancies of synonomy, from that of Mr Salter's lists relating to Wrae quarry, the Kirkcudbright deposits, etc.

The descriptions of these fossils appeared in a series of papers contributed to the pages of the *Annals and Magazine of Natural History*, between the years 1850-52. Our present subject requires from us only a notice of three of these. In the first paper, "On some New Silurian Mollusca,"† were described *Orthoceras politum* (M'Coy) from Glenwhapple, *Bellerophon subdecussatus* (M'Coy) from Mulloch, and *Trochus Moorei* (M'Coy) from Dalquharran. The second paper, published in the same year,‡ contained *Hemithyris angustifrons* (M'Coy), from Mulloch Hill; *H. nasuta* (M'Coy), found at Craighead Quarry; *Orthisina Scotica* (M'Coy), Craighead; and *Holopella cincta* (M'Coy), again from Mulloch.

The third paper, "On New Lower Palæozoic Mollusca," published in 1852,§ completed M'Coy's investigations in this direction, when we were introduced to *Murchisonia cancellata* (M'Coy), from Mulloch; *M. simplex* (M'Coy), from Dalquharran; *Maclurea macromphala* (M'Coy), Craighead; and *Eccyliomphalus Scoticus* (M'Coy), from Mulloch.

The last-mentioned fossil is placed like *Bellerophon* and *Maclurea* in the order Heteropoda. The shell is thin, and curved or discoidal, the whorls few and widely separated from one another, and the coils in one plane. It probably bears some relation to the genus *Cyrtolites* (Conrad), a Silurian fossil, and to *Phanerotinus* (Sby.), a similar loosely-

* Brit. Assoc. Report for 1850 (pub. 1851), pp. 103-107.

† Annals, 1851, vii., pp. 45-63.

‡ *Ibid.*, pp. 387-409. § *Ibid.*, 1852, x., pp. 189-195.

coiled shell from the Carboniferous limestone. The true affinities of all these curious shells have yet to be worked out.

The first part of Professor M'Coy's great work, "The British Palæozoic Fossils," appeared in 1851, and extended over the next two years. It contains a more detailed list of organisms, with carefully drawn-up descriptions of the fossils from the south of Scotland contained in the Woodwardian Museum, Cambridge. A moderate estimate of the Girvan Mollusca, given by Professor M'Coy, is—Brachiopoda, 15 species; Gasteropoda, 14 species; Cephalopoda, 4 species; and Pteropoda, 1 species.

The essential feature of M'Coy's list is the increase in the number of Brachiopoda and Gasteropoda, and the occurrence of the curious genus *Eccyliomphalus*, previously referred to. It is arranged in a very convenient way for reference, under localities, and may be consulted with advantage by those who take an interest in the subject.

In addition to the fossils from Girvan, mentioned by M'Coy, he described in the same work 17 species of Mollusca from the Wenlock series of Kirkcudbrightshire.

We must now leave the Girvan and neighbouring districts, and take a glance at the progress made elsewhere. In the last edition of "Siluria,"* the late Sir R. Murchison wrote thus—"To the west of Lesmahagow there is an ascending passage upwards from clay slates with calcareous nodules and a rare *Orthoceras*, into black schists with large crustaceans, which manifestly stand in the place of the uppermost course of the Ludlow Rocks of Shropshire. This important fact was discovered by Mr Robert Slimon, of Lesmahagow."†

This remarkable discovery of Mr Slimon had been before chronicled by Sir R. Murchison in 1856, whose curiosity was excited at the previous meeting of the British Association in Glasgow, where Mr Slimon's collection was exhibited.‡

Reluctantly omitting any reference to the wonderful Crustacean remains yielded by the Upper Silurian beds of Lesma-

* 4th edit., 1867, p. 160. † *Ibid.*

‡ "On the discovery by Mr R. Slimon of fossils in the uppermost Silurian Rocks near Lesmahagow," etc. (Quart. Jour. Geol. Soc., 1856, xii., pp. 15, 25).

hagow as being without the scope of the present remarks, we can only notice the three shells found at the same time by Mr Slimon. These were "a rare Orthoceras" in calcareous nodular concretions on Nutbery Hill, a curious little Brachiopod, at that time identified with *Lingula cornea* (Sby.) and a Univalve, *Trochus helicites* (Sby.).*

Until 1858 these organisms constituted the entire fauna known from these interesting rocks. But at the meeting of the British Association in that year, at Leeds, the late Dr Page announced† the discovery of five other fossils, all Bivalves, referable to the genera *Modiolopsis, Nucula, Pterinea,* and *Avicula.*

Contemporaneously with the researches of Mr Slimon at Lesmahagow, others, equally important in their results, were in progress in the far North of Scotland. A former President of this Society, the now venerable and much respected Charles William Peach, had, whilst residing at Wick, and during excursions to the north-west part of Sutherlandshire, discovered fossils in the crystalline limestone of Durness. According to the views entertained by Murchison this limestone and associated quartz rocks were of Lower Silurian age,‡ and anterior to Peach's discovery, he tells us Professor Nicol and himself had found an *Orthoceratite,* "but too imperfect to be referred to any known species."§

The object of Mr Peach's first visit to the storm-bound coast of Sutherlandshire appears to have been to inspect a wreck, and to this unfortunate occurrence we are indebted for the important discoveries which followed.|| The first shell found was a *Maclurea,* the same fossil we have seen playing an important part in Girvan conchology. To this were subsequently added many others, all tending to prove, on critical examination by our old friend Salter, the correctness of Murchison's views. Further than this, Salter's determinations conclusively showed the near relation borne

* "On the discovery by Mr R. Slimon of fossils in the uppermost Silurian Rocks near Lesmahagow," etc. (Quart. Jour. Geol. Soc., 1856, xii., pp. 18, 24); Siluria, 4th edit., p. 160.

† Brit. Assoc. Report for 1858 (pub. 1859), p. 104.

‡ *Ibid.,* 1855, pt. 2, p. 85.

§ Siluria, 4th edit., 1867, p. 164; Quart. Jour. Geol. Soc., xv., p. 355.

|| *Ibid.*

by these Durness beds to certain of the Lower Silurian rocks of America.

Murchison's paper detailing these facts, with Salter's descriptions of the fossils, appeared in 1859.* We see at a glance that the fauna discovered by Mr Peach consists exclusively of two groups of shells only—the univalves and chambered shells. Of the former the most important is, of course, the large *Maclurea Peachii,* a very remarkable species of this strange genus. It possesses a massive operculum, with a produced and spirally inrolled nucleus resembling a *Capulus,* at once distinguishing it from its fellow species.

The resemblance of *Maclurea* to some bivalves of the group Rudista has been commented on by several writers. It was so referred originally by one of our first Conchologists, the late Dr Samuel P. Woodward,† and placed near the genera *Caprotina* and *Caprinella.* Later Dr Woodward showed its relation to the Heteropoda, probably a solid sedentary form allied to *Bellerophon.*‡

A second species of *Maclurea* is also present, and appears to be identical with an American fossil.

The full list of Gasteropoda from the Durness limestone is as follows:

Maclurea Peachii, Salter.
„ *matutina,* Hall? (Calciferous Group of North America=Lowest Silurian).
Hormotoma gracilis, Hall? (Trenton and Hudson River Groups=Llandeilo and Caradoc).
Murchisonia angulocincta, Salter.
„ *bellicincta,* Hall? (Ditto).
Ophileta compacta, Salter (Calciferous Group of North America=Lowest Silurian).
Pleurotomaria Thule, Salter (allied to *P. subconica,* Hall, of the Trenton and Hudson R. Groups).
Raphistoma labrata, Emmons (Calciferous Group of North America).

* "On the Succession of the Older Rocks in the northernmost Counties of Scotland," etc. (Quart. Jour. Geol. Soc., xv., pp. 353, 421); and "Fossils of the Durness Limestone" (*Ibid.,* pp. 374-381).

† Salter, *loc. cit.*

‡ Man. Mollusca, 1851-56, p. 202.

Five species of Cephalopoda are present in the Durness limestone, and amongst them we again observe a strong similarity to American forms. In fact, out of the five, three are provisionally referred to American species, whilst the fourth has a strong resemblance to another. Besides these shells Salter was able to determine what he believed to be a new genus, *Piloceras*, a broad, conical, and slightly curved shell. The siphuncle and septa are combined in one, as a series of conical curved partitions, which fit into each other sheathwise. Salter considered this to be the simplest type of Cephalopod shell known. The genus is clearly allied to the American forms called *Endoceras*, in which the siphuncle is very large, with a pointed termination.

The full list of Durness Cephalopoda comprises—

Orthoceras mendax, Salter (near *O. multicameratum*, Hall, of the Trenton Group=Llandeilo).
Orthoceras arcuoliratum, Hall, Do.
" *vertebrale*, " Do.
" *undulostriatum* " Do.
Piloceras invaginatum, Salter.

The analogy of the Durness fossils with American forms is not only that of identity of species, but even in lithological character and general appearance. Many of the fossils derived from this "hard, marbled and veined grey limestone" are filled with siliceous matter, and their mode of weathering quite bears out the analogy instituted by Murchison between them and specimens sent from kindred strata in Canada by the late Sir W. Logan.*

In concluding his remarks on the American facies of the Durness fossils Salter observed, "there are, then, *five identical*, three doubtful, four which may fairly be called representative forms (the *Maclurea*, the *Orthoceras*, *Murchisonia angulo-cincta*, and *Pleurotomaria*), and *Piloceras* is a new genus found in Canada and in Scotland." "That this truly North American assemblage should be found in the extreme north of Scotland, on the same parallel as the Canadian—that species of *Maclurea* and *Raphistoma*, resembling those of the

* Quart. Jour. Geol. Soc., xv., p. 369.

St Lawrence basin, and *Orthocerata* bearing large siphuncles like those of North America, Scandinavia, and Russia, should occur in Scotland, and yet be scarcely known further south, is at least suggestive of a geographical distribution—perhaps even of climatical conditions—not very unlike that of more modern times." *

It is time we now returned to a consideration of the contents of our more familiar beds of the south. It will be remembered that up to about 1849 the only fossil of any importance found in the Pentland Hills was an *Orthoceras.* This appears to have remained the sole representative till the discovery of another shell, *Rhynchonella,* by Mr A. Geikie (now Director-General of the Geological Survey), in 1858.† In the meantime specimens of this *Orthoceras* having found their way into Mr Salter's hands, probably through Sir Roderick Murchison, it was named, in honour of its distinguished discoverer, *Orthoceras Maclareni.* ‡

In 1859, the systematic collection of fossils from the Pentland Hills, on behalf of the Geological Survey, was commenced by the late Mr Richard Gibbs, whilst the Edinburgh district was in course of being mapped by Messrs Howell and Geikie. § Although a sufficient suit of organic remains were obtained to show the general relation of the beds to the corresponding series elsewhere, the collection made by Gibbs was far from exhaustive, and he left what may be looked upon as virtually a new field for future explorers of fossils. During the Survey examination only two localities were noted as fossiliferous, viz., Hare Hill and the beds of the North Esk reservoir. From the former two kinds of shells only were obtained, the *Rhynchonella compressa,* and a Pteropod called *Theca.* In all twenty-six species of shells were collected, viz., Brachiopoda, Bivalves, and Univalves, seven species each, Cephalopoda, three species, and Pteropoda, two species.

The Brachiopoda do not call for any particular remark, but

* Quart. Jour. Geol. Soc., xv., p. 381.

† Mem. Geol. Survey, Scotl., No. 32, pp. 5, 6.

‡ Siluria, 3d edit., 1859, p. 176, foss. 24.

§ "Geology of the Neighbourhood of Edinburgh" (Mem. No. 32, 1861, 8vo, with Appendix, by J. W. Salter).

Salter's list is chiefly valuable as a means of comparison between the Mollusca of this and the English Upper Silurian areas. There is probably much in Salter's remark that the Ludlow fauna of the Pentland Hills is representative only of that of England, and not identical with it. He excepted from this category the Pteropoda or pelagic Mollusca, on the supposition that their erratic habits would lead them from one area to another. A healthy impetus appears to have been given to local Palæontology by the Survey researches. Nothing so contributes to the solution of geological problems, in fact I may say natural history problems in general, as a well-devised scheme of exploration on the part of those constantly on the field of operations. Particular facilities given to them are denied to chance visitants, or those employed only on temporary investigation, either official or private. Our knowledge of those districts is invariably the best, in which a few prominent members of local societies who constantly make the unravelling of its natural features, physical and organic, their prominent study. The more discussion we have on these matters the better, and the sooner we shall arrive at some definite conclusion.

The operations of the Geological Survey in the Pentland Hills were closely followed up by those of the late Mr G. C. Haswell, for some time secretary of the Edinburgh Geological Society. His little work, "On the Silurian Formation in the Pentland Hills," * affords a very good *resumé* of the work done up to the time he wrote, including descriptions of all the organisms known from thence. In addition to the species determined by Mr Salter, Haswell was successful in obtaining several additional forms, notably amongst the Brachiopoda. I think we must look upon the recognition of his work afforded later on by our greatest authority on that class of shells, Thomas Davidson, Esq., F.R.S., as particularly creditable and honourable to Mr Haswell. Haswell showed the existence in the Pentland Hill strata of a species of the genus *Merista*, named by him *Merista Maclareni*, and he further called attention to the presence in a certain bed of multitudes of a *Rhynchonella*, which he named *R. Pentlandica*. This

* 8vo, Edinburgh, 1865.

author added to the Pentland fossil fauna some half dozen new forms of Mollusca, and greatly invigorated the study of its Palæontology.

In Mr Haswell's steps followed two earnest workers, both members of the Edinburgh Geological Society, Messrs D. J. Brown and J. Henderson. The results of their work in the Pentland Hills is summed up in a paper "On the Silurian Rocks of the Pentland Hills," published in 1868,* and in it we find the most complete list of Silurian organisms yet given from the district in question. Brown and Henderson were the first, I believe, notwithstanding Haswell's researches, to systematically collect the Pentland fossils, bed by bed; and there can be no possible doubt that this method of working is the only true one, if accurate geological results are wished for. They showed the preponderance of certain forms of Mollusca in certain individual strata, thereby indicating what we may call the "zone" of such and such a species, and designated by special letters. For instance, they discovered a bed of shale weathering into cuboidal fragments, and characterised by an abundance of the Brachiopod genus *Strophomena;* another full of a shell called *Leptæna;* and a third entirely peopled by our old acquaintance *Orthoceras Maclareni.* Again, Haswell's *Rhynchonella Pentlandica* almost wholly composes another stratum (Bed A), whilst a shell, we shall hereafter see abounding at Lesmahagow, *Trochus helicites,* is characteristic of the yellow bed immediately underlying those red strata considered by Professor A. Geikie to be of Old Red Sandstone age.

The results of their work in the Pentland Hills led Brown and Henderson to the important conclusion that the whole series represented two formations of different ages, equivalent to the English Wenlock and Ludlow groups. From the base of the section at the North Esk (Bed A), containing *Athyris compressa,* up to the point at which *Leptæna transversalis* dies out (Beds E and F), the series is regarded as Wenlock, whilst Bed H is considered to be of Ludlow age, including certain red beds at the top of the series. By Mr Salter the whole group was looked upon as Ludlow, although it must

* Trans. Edinb. Geol. Soc., i., pt. 1, pp. 23-33.

not be forgotten that Professor Geikie had already, in 1867, expressed an opinion that some portions of the series might with advantage be referred to the age of the Wenlock group.*

The number of shells determined by Messrs Brown and Henderson from the fossiliferous Silurian strata of the Pentland Hills, may be taken in round numbers as—

Brachiopoda,	. . .	25 species.
Bivalves,	. . .	19 or 20 species.
Gasteropoda,	. . .	11 species.
Pteropoda,	. . .	3 "
Cephalopoda,	. . .	7 "
	Total, .	65 species.

Of the Brachiopoda twenty species are decidedly of a Wenlock facies, whilst eighteen of these alone occur in the Bed D. The Bivalves show a similar inclination towards the Wenlock. Only six out of the nineteen or twenty species are exclusively Ludlow, the remainder being again Wenlock. Brown and Henderson added by their collecting much to our knowledge of the Upper Silurian Brachiopoda, discovering for the first time in Britain the peculiar *Strophomena Walmstedti* (Lindst.). † The whole of their collections in this class of Mollusca were examined and determined by Mr T. Davidson, and form the subject of a separate work, "The Silurian Brachiopoda of the Pentland Hills," ‡ and published about this time. In this useful and highly scientific work are enumerated no less than twenty-six species of Silurian Brachiopoda as occurring in the Pentlands. Of these *Lingula lata* (Sby.), *Spirifera crispa* (Linn.), *Meristella Maclareni* (Haswell), and *Rhynchonella Pentlandica* (Haswell), all from Bed H, are Ludlow species, and characteristic of that group, whilst the remainder are decidedly Wenlock. One entirely new shell is described, the *Strophomena Hendersoni* (Davidson), and another rare form, not frequently met with in the British Islands, the before-mentioned *Strophomena Walmstedti*. The mineral condition of the Pentland Hill fossils is peculiar and

* Trans. Geol. Soc., Glasgow, 1868, iii., pt. 1, p. 94.

† *Ibid.*, p. 23.

‡ 4to, Glasgow, p. 24, pl. 3, *n. d.*

characteristic. Either internal casts or external impressions are the state of the remains, a mollusc or any other fossil with traces of the shell or integument remaining, being a great rarity. Some of the shells are met with in considerable numbers—thus *Rhynchonella Pentlandica* occurs in millions in Bed H, and is an essentially Pentland form. In Bed D, *Leptæna transversalis* is the most abundant Brachiopod, whilst numerous other instances might be cited. Mr Davidson has also pointed out how much smaller in size the Pentland species are than is usually the case with Silurian Brachiopoda.

Since the publication of Davidson's work, Mr J. Henderson has added * two further fossils to this admirable list, *Discina striata* and *D. rugata.* In 1874 Mr D. J. Brown announced the discovery of fossiliferous blocks in the conglomerate of the Habbie's Howe gorge, Logan Water.† These blocks contain a goodly number of fossils, corals, shells, and traces of trilobites. The determination of such remains has been rendered difficult by the mineralisation they have undergone. Further, it not unfrequently happens, that in splitting these blocks, instead of exposing the outer surface of the shells, the substance is itself split and fractured. No true appreciation of the surface characters can be obtained, and identification is rendered very difficult. I would indicate the fossiliferous blocks in question as one of the most interesting directions for future research in the Pentland Hills.

The latest addition to the fauna now under consideration comprised eight species of Mollusca, made in 1874 from the collections of Messrs Brown and Henderson.‡ These comprise a bivalve shell apparently referable to a Lower Silurian genus *Ambonychia,* and named *A. Hendersoni,* and if correctly identified, a very interesting fact. Two species of the characteristic Silurian genus *Pterinea* were likewise observed, and one of *Modiolopsis.* Two species of *Ctenodonta* also occurred,

* "On some Silurian Fossils found in the Pentland Hills" (Trans. Edinb. Geol. Soc., 1874, ii., pp. 373-375).

† "On the Silurian Rocks of the South of Scotland" (*Ibid.*, p. 320).

‡ Etheridge, "Notice of Additional Fossils from the Upper Silurian of the Pentland Hills" (*Ibid.*, pp. 309-313).

one already known, the *C. quadrata* (M'Coy), and an undescribed form called *C. Pentlandica.* In addition to these shells were a Gasteropod and two Cephalopods, raising the total number of Mollusca at all well defined to about seventy-three or -four species.

We must not quit the Silurian rocks of the home county, however, without reference to the later work of the Geological Survey. Professor Geikie was fortunate in securing the services of a most able and enthusiastic collector, by whom the whole of the localities previously known, and several new ones, were diligently searched, and large and varied collections made. I refer to my friend Mr James Bennie. In collecting from these beds Mr Bennie has wisely adopted the plan followed out by Messrs Henderson and Brown, and taken the strata bed by bed at the various exposures of the rocks. His collections, I am sorry to say, have never been thoroughly investigated, and no part of the results published. There are, I know, several new and interesting shells, belonging to the class Lamellibranchiata, besides forms in other classes, which would well repay study. A selection of these may be seen in the Museum of Science and Art.

The Molluscan Fauna of the great Black Shale group of the south of Scotland—the Moffat series—has hitherto proved of the most scanty description. The first shell recorded from these black shales was, I believe, a small Brachiopod, called by M'Coy *Siphonotreta micula,* and very characteristic of certain portions of the Llandeilo series in Wales. It was discovered by Professor Harkness, and specimens were presented to the Museum of Practical Geology in Jermyn Street.* About the same date Mr J. Stevens found in the Moffat shale a *Tentaculites,*† a small elongate shell, at one time regarded as the tube of a tubicolar worm, but now believed by our best authorities to be a free-swimming mollusc of the class Pteropoda.

Later on a second Brachiopod was discovered by our president, Professor H. A. Nicholson, in the black shales of Dobb's Linn, Moffat. The specimens were sent to Mr David-

* Cat. Foss. Mus. Pract. Geology, 1865, p. 17.

† Geol. Mag., Sept. 1865, p. 431.

son, who provisionally referred it to a genus of Lower Silurian Brachiopoda, met with commonly in Russia, and called *Acrotreta* by Professor Kutorga. It is very appropriately named by Davidson *Acrotreta Nicholsoni*, in his paper "On the Earliest Forms of Brachiopoda hitherto discovered in the British Palæozoic Rocks."* Between the date of this paper (1868) and the present time two more shells have been added by Mr Charles Lapworth,† and this, I think, concludes the molluscan fauna hitherto noticed from the rocks in question. The shells referred to are *Discina Portlockii* (Geinitz), mentioned in a very interesting paper "On the Silurian Rocks of the South of Scotland,"‡ from the Hartfell and Glenkiln shales, and *Lingula brevis* (Portl.) from the Hartfell Shales.

The complete List from the Black Shale series is therefore—

Acrotreta ? Nicholsoni (Davidson).
Discina Portlockii (Geinitz).
Lingula brevis (Portlock).
Siphonotreta micula (M'Coy).
Tentaculites sp.

A very extensive area has been traversed by Mr A. Macconochie in making collections from the Black Shale group for the Geological Survey, but no additions to this list have rewarded his researches. The life appears to have been almost entirely graptolitic, and in all probability the conditions were not conducive to molluscan existence.

In the succeeding Queensberry Grit group the impressions of Orthoceratites have been found at times, but usually in too crushed a condition to be recognisable. Specimens of this description were met with by Mr A. Macconochie, near Moniaive, when collecting in the south-west of Scotland.§

We left the history of the Upper Silurian rocks and fossils of Lesmahagow at that early point in their history, when only traces of molluscan life had just been discovered by Messrs

* Geol. Mag., 1868, v., p. 313, t. 16, f. 14-16. † Now Professor.
‡ Trans. Geol. Soc., Glasgow, 1874, iv., pp. 164-174.
§ Mem. Geol. Survey, Scotl., Expl. 9, 1877, p. 48.

Slimon and Page. We may now resume this branch of our subject.

The addition of a considerable suite of Mollusca by the Geological Survey after this period was first announced by Professor Geikie, in his valuable paper "On the Order of Succession amongst the Silurian Rocks of Scotland."*

A small elongated *Lingula* is common at Lesmahagow associated with the remains of large crustaceans, and before referred to under the name of *L. cornea.* The researches of Mr Davidson† have placed it beyond doubt that the form found at Lesmahagow should more properly be referred to another species, the *L. minima* (Sby.). *Lingula cornea* is the characteristic species of the "passage beds" of Murchison, or those strata intermediate between the uppermost Ludlow beds and the base of the succeeding Old Red sandstone in the west of England. On the other hand, *L. minima* is typical of the Downton sandstone, or highest zone of the Upper Silurian of the same region. It will be thus seen that the proper identification of this little shell had a very interesting bearing on the exact position held by the Lesmahagow series in the geological scale, when compared with other districts.

The "grey and reddish shales and sandstones" of Lesmahagow, known as the "*Lingula* and *Trochus* beds,"‡ are very interesting to the conchologist from the innumerable numbers in which the little shell called *Trochus helicites* occurs, and its state of preservation. The entire bed is in places quite made up of this form, and always in the state of decorticated casts. To render their appearance more characteristic, the substance of all the casts is riddled with thousands of examples of a little parasitic worm (*Spirorbis*).

Although the "*Trochus*" is found in some of the lower beds of the Lesmahagow section accompanied by *Lingula minima,* and a bivalve, the so-called *Modiolopsis Nilssoni,* it is in strata approaching nearer to the top of the series that the abundance of molluscan life is met with.

Combining the results of private workers' researches with

* Trans. Geol. Soc., Glasgow, 1868, iii., pt. 1, p. 95.

† Sil. Brach. of the Pentland Hills, p. 22.

‡ Salter, Mem. Geol. Survey, Scotl., No. 32, p. 132.

those of the Geological Survey, notably the collection made by Messrs B. N. Peach and A. Macconochie,* and we have the following results as regards molluscan life of the Silurian series of Lemahagow:

Brachiopoda, ...	4 species.
Bivalves, ...	7 „
Gasteropoda, ...	1 „
Pteropoda, ...	1 „
Cephalopoda, ...	3 „
Total, . . .	16 species.

Lingula minima we have already referred to. Two others of the Brachiopoda are only indicated species, and the third *Strophomena rhomboidalis* (Wahl.), has a wide range throughout the Silurian series. The Bivalves are essentially of a high Silurian type, and correspond to those of the English Ludlow group.

In 1866 appeared the seventh part of Mr Davidson's magnificent work, "A Monograph of the British Fossil Brachiopoda," forming the first part relating to the Silurian species. It is unnecessary to recapitulate the names of the shells described by Mr Davidson, as they have, more or less, been referred to in previous pages. Five species were described and drawn from Scotch Silurian rocks in the first part, referable to the Lingulidæ and Discinidæ. In the following year the second part of this work appeared containing descriptions of seven additional species, accompanied by figures in the clear and vigorous style so peculiarly the author's. The third and fourth parts were published in 1869 and 1871 respectively.

Of Mr Davidson's work it would be presumptuous on my part to speak. One feature, however, may be mentioned, and taken to heart by many other palæontologists—his work is eminently practical, for his descriptions are the result of work executed both in the field and cabinet. In 1835 Mr Davidson accompanied the late Mr J. H. Cunningham in his

* Mem. Geol. Survey, Scotl., Expl. 23, 1873, pp. 55, 56.

survey of the Lothians, and assisted him in his essay* on those counties. He also visited the fossiliferous localities of Lanarkshire, and accompanied Messrs Henderson and Brown in some of their excursions amongst the Pentland Hills.

We have seen the examination of the Edinburgh neighbourhood, concluded about 1860, and the memoir with lists of fossils published in 1861. The services of Mr R. Gibbs, the collector to the English Survey, were next employed at Girvan, where he worked during the years 1864-65. A large number of fossils were acquired during the visit, which were examined and determined in London by Mr R. Etheridge, F.R.S., assisted by Dr John Young, now Professor of Geology and Natural History in the University of Glasgow. No detailed account of these fossils has ever appeared, but several short lists have been published in a desultory manner in the "Survey Explanations of Maps," the chief of these being Explanation 7,† with list of fossils from Aldons and Ardmillan Brae; Explanation 14,‡ containing the fossils of the Craighead limestone, Drummuck burn beds, and Kirkhill; and Explanation 3,§ with a general list from the whole of the localities visited both by Mr Gibbs, and afterwards by Mr Arthur Macconochie. The collections thus obtained are deposited in the Museum of Practical Geology, London, and the Geological Survey Office in Edinburgh.

The official collections, however, sink into insignificance when compared with those amassed during a series of years by Mr and Mrs Robert Gray. Mrs Gray began collecting around Girvan after the death of Alexander Maccallum, but quite independently of any knowledge of his localities. Both Mr and Mrs Gray visited Penkill Glen in 1855, but were not successful in finding much; but in the summer of 1859 a fresh locality was discovered and assiduously worked at for six months. For several years in succession, after 1859, these diligent researches were continued with the assistance of the late Mr Thomas Anderson, and they have been carried on uninterruptedly ever since. Words of mine will not convey the diligence, earnestness, and acumen displayed by Mr and Mrs Gray

* "The Geology of the Lothians" (Mem. Wernerian Nat. Hist. Soc.).

† 1869, pp. 9, 10. ‡ *Ibid.* § 1877, pp. 29-34.

in the accumulation of their fossils. Two entirely separate collections have been made by Mrs Gray. The first was presented to the Hunterian Museum, Glasgow, about 1865 or 1866, and the second now forms, without doubt, the most complete series of Silurian fossils ever brought together in Scotland. The second collection has literally been the work of Mrs Gray's own hands, and at a moderate estimate it may be stated that in accomplishing this work from 20,000 to 30,000 specimens have been obtained. Several of the most interesting forms of Brachiopoda, described by Mr Davidson, were found by Mrs Gray, such as, *Leptæna Youngiana, Triplæsia Grayæ, Orthis Girvanensis*, etc. The results of her first gatherings were communicated in a series of short papers to the *Proceedings* of the Glasgow Natural Society, by Mr Gray, and Mr John Young, F.G.S.

The most important of these were, "Note on a New Brachiopod Shell, *Triplæsia Grayæ* (Davidson),"* by Mr Young; "Note on *Leptæna Youngiana* (Davidson),"† by Mr Gray; "Notes on the Genera of Extinct Fossil Shells, *Bellerophon* and *Porcellia;*"‡ and "Notes on a Series of Fossils from the Silurian Rocks of the Girvan Valley,"§ by Mr Young. In this paper is announced the discovery of a Russian Silurian Brachiopod not previously known to occur in Britain.

The shell previously mentioned, *Leptæna Youngiana*, is regarded by Mr Davidson as a variety of *Leptæna transversalis* (Dalman). For my own part, I should be inclined to regard this as a distinct and separate species, but if a variety of anything it appears to have more affinity with *L. tenuicincta* (M'Coy).

In 1876 Professor John Young read a short paper before the Glasgow Natural History Society,‖ on a Silurian fossil from the neighbourhood of Girvan, which he referred to Salter's genus *Stenotheca*, a free-swimming shell of the class Pteropoda. Professor Young considers that this organism has greater affinity with the Phyllopod Crustacea than with the Pteropoda. He remarks that the shell has the appearance

* Proc. Glasgow Nat. Hist. Soc., 1868, i., pt. 1, p. 207.

† *Ibid.*, 1869, i., pt. 2, p. 229.

‡ *Ibid.*, 1875, ii., pt. 1, p. 16.

§ *Ibid.*, 1876, ii., pt. 2, p. 166.

‖ Proceedings, 1876, ii., pt. 2, p. 223.

of valves "found in pairs, and in many cases the similar margins are turned towards each other, just as happens in the *Dithyrocaris*."

In 1876 the British Association met in Glasgow, and with the view of affording geological visitors every facility for following out their favourite pursuit, a committee of the Glasgow Geological Society undertook the preparation and publication of a small geological guide. This volume, entitled "A Catalogue of Western Scottish Fossils, with an Introduction on the Geology and Palæontology of the District,"* is by Messrs James Armstrong, J. Young, F.G.S., David Robertson, F.G.S., and Professor John Young, M.D. Sufficient thanks on the part of all workers interested in Scotch geology cannot be accorded to these gentlemen for their disinterested trouble in so readily placing before others information gathered over a long series of years. In the portion relating to the Silurian deposits an excellent list of fossils from Girvan is given.

The last reference I have to make to this branch of my subject, is to a short paper by Mr Davidson, "Notes on Four Species of Scottish Lower Silurian Brachiopoda."† In this communication a new species of the peculiar genus *Siphonotreta* is described, found by Mrs Gray in the Craighead limestone, and named *Siphonotreta Scotica.* Two very large forms of *Lingula* had also been met with by Mrs Gray, and these Mr Davidson referred to *Lingula Canadensis* of Billings, a characteristic shell of the Hudson River group of North America, and *Lingula quadrata* (Eichwald). The latter is a Russian species, and it is curious to note that *Siphonotreta* is also essentially a Russian Silurian genus.

A final summary of the Girvan Silurian Mollusca, gathered from the various papers and lists just quoted, and after deducting synonyms and certain doubtful determinations, yields the following numbers:

Brachiopoda, ...	53 species.
Bivalves, ...	12 „

* Proceedings, 1876, ii., pt. 2, p. 164, Glasgow, 8vo.
† Geol. Mag., 1877, iv., pp. 13-17, t. 2.

Univalves, ...	28	species.
Pteropoda, ...	6	"
Cephalopoda, ...	11	"

In concluding this portion of my remarks, it only remains to refer again to the Upper Silurian beds of the Kirkcudbright district. The last reference made to them was in connection with Professor M'Coy's determination of fossils collected for Professor Sedgwick. In 1851 Professor Harkness noticed the occurrence of *Orthoceratites* in the flagstones of Balmae, in a paper "On the Silurian Rocks of Dumfriesshire and Kirkcudbrightshire."* Three species were found by Harkness—*Orthoceras Sedgwickii* (Forbes), *O. annulatum* (Sby.), and *O. tenuicinctum* (Portlock). Nothing further has been published of any note on fossils of these beds so far as I am aware, but in September 1874 Mr James Bennie made a large collection of organic remains, which, it is to be hoped, will be described some day. One of the most noticeable is a large *Orthoceras*, commonly met with in pieces and fragments. Entire specimens sometimes occur, and these show the character and arrangement of the numerous close septa exceedingly well. In the many pieces of fragments found the convex surfaces of the chambers show very peculiar and interesting groovings and markings, which would well repay detailed study.

Such, Gentlemen, is a brief and very incomplete history of Silurian Conchology in Scotland. It is yet, comparatively speaking, an open and unexplored field, and much remains to be done in the systematic description of the shells from the Silurian deposits of the Pentland Hills, the N.-W. Highlands, Girvan, and Kirkcudbrightshire.

CONCHOLOGY OF THE OLD RED SANDSTONE OF SCOTLAND.

"In the ichthyolite beds of Cromarty and Ross, of Moray, Banff, Perth, Forfar, Fife, and Berwickshire, not a single shell has yet been found; but there have been discovered of late, in the upper beds of the Lower Old Red Sandstone in

* Quart. Jour. Geol. Soc., vii., pp. 46-65.

Orkney, the remains of a small delicate bivalve, not yet described or figured, but which very much resembles a Venus." *

So wrote one of the most elegant and masterly writers yet known in the science of geology, and what was true of the conchology of the Scotch Old Red at that date holds good now. So far as I am aware no shells have ever been described from any deposits truly referable to that period. The delicate bivalve spoken of by Miller is in reality a small Phyllopodous Crustacean, named *Estheria*, and not a Mollusc at all. This was first suggested by the late Dr S. P. Woodward at the Liverpool meeting of the British Association in 1854,† and was demonstrated by Professor T. Rupert Jones afterwards.‡

THE CARBONIFEROUS CONCHOLOGY OF SCOTLAND.

Carboniferous Conchology, I may say Carboniferous Palæontology generally, has been studied in Scotland with much greater assiduity than that of her Silurian rocks. This is probably due to three causes—the association of the organic remains with strata of economic value, the situation of the great centres of population on and near rocks of Carboniferous age, and, as a rule, the better state of preservation of the fossils.

Few works complete in themselves have been written on Scotch Carboniferous fossils. On the other hand, a very large number of contributions of the utmost importance have appeared in the pages of scientific magazines and journals of learned societies.

It will not be out of place to mention here the name of one who may, perhaps, be regarded as the first collector of shells and other organic remains of the geological period now under consideration — the Rev. Mr Wodrow, minister of Eastwood (Pollokshaws), near Glasgow, who flourished at the beginning of the last century.

In Sir John Sinclair's "Statistical Account of Scotland,"

* The Old Red Sandstone, 7th edit., 1859, p. 116.

† *Vide* Jones, Mon. Foss. Estheriæ, 1862, p. 15. ‡ *Ibid.*

we are informed that Wodrow was born in 1680, and died in 1734. "Besides his worth as a minister, he was a man of extraordinary industry and application to such researches as were connected with the antiquities of Scotland. . . . He was among the first who attended to natural history in this country, and he left behind him a small museum of fossils, chiefly collected from his own parish, and also a collection of medals."*

The first work published bearing on Scotch Carboniferous Palæontology is that remarkable and scholarly book, "The History of Rutherglen and East Kilbride,"† by the Rev. David Ure. In this clever work, which, as the title denotes, is partly antiquarian, partly historical, many pages are devoted to the geology of the district. Indeed, the whole of the sixth chapter treats of the "Extraneous Fossils" found around East Kilbride, and contains "An account of vegetable impressions, petrified wood, shells, entrochi, coralloids, and fishes' teeth." The majority of Ure's fossils were collected at "Laurieston," a locality which has been ascertained by Mr James Bennie to be the Brankamhall, East Kilbride, of the present day.‡

Ure's book occupies the same position with regard to Scotch Palæontology that the equally classic work of Lhwyd,§ published at a much earlier date, does to that of England and Wales.

A very interesting life of Ure has appeared from the pen of Mr John Gray, "Biographical Notice of the Rev. David Ure," etc.,|| who, speaking of the "History," considers it to be "the production of no common mind, and contains within itself material of much more than a local value."¶

David Ure, born in Glasgow, Mr Gray tells us, was the son of a weaver. He educated himself under disadvantageous circumstances, but after passing through a course of study at Glasgow University, was licensed and appointed assistant in the ministry of East Kilbride. In 1796 he was presented

* Stat. Acc. Scotland, 1796, xviii., pp. 210, 211.

† Pp. 334, pls. 20, 8vo, Glasgow, 1793.

‡ Davidson, Geologist, iii., p. 17.

§ Lithophylacii Britannici Ichnographia, etc., 8vo, Oxonii, 1699.

|| Pp. 59, 8vo, Glasgow, 1865.

¶ *Loc. cit.*, p. v.

to the church of Uphall, in Linlithgowshire, by Lord Buchan, but only lived two years to fulfil his new duties. In addition to his "History," Ure assisted Sir John Sinclair in the preparation of the "Statistical Account of Scotland."

Of the "petrified productions of the sea," those only which at present concern us are the shells. The excellence and truthfulness to nature of the plates has rendered the identification of the species depicted a possible and agreeable task—one which has been carried out by Messrs James Armstrong and John Young, F.G.S., with success. The list is inserted in the work by Mr J. Gray previously referred to.* An historical copy of the "History of Rutherglen," etc., is in the library of the Department of Geology and Palæontology, in the Museum of Natural History. It is a presentation copy from the Rev. J. Fleming to James Sowerby, accompanied by a letter of gift, dated "Flisk," 26th December 1814. There is also a memorandum by the recipient of the arrival of the precious volume on the 23d February 1815.

The forms which Messrs Armstrong and Young consider specifically recognisable number about thirty, and are distributed as follows: Brachiopoda, 14 species; Bivalves, 5 species; Gasteropoda, 8 species; Cephalopoda, 4 species, in addition to several others referred to in the body of the work. In the face of the excellent list referred to, it is unnecessary to recapitulate the species here.

An interval of many years took place between the publication of Ure's book and the appearance of the next work on record, "The Mineral Conchology of Great Britain," by the Messrs James and James de Carle Sowerby.

The "Min. Con.," as it is familiarly called, was published† in 113 parts between the years 1812 and 1846. The work was commenced by James Sowerby, the founder of the family of that name, in June 1812, and under his direction, up to November 1822, sixty-six parts were issued. After his death it was conducted by James de C. Sowerby, from January 1823 to January 1845, to the completion of the 113th part. The facts connected with the publication of

* "Biographical Notice of the Rev. David Ure," etc., pp. 49-55.

† 7 vols. and Index, 8vo, London, 1812-1846.

this great work are of highest importance to Palæontologists, and are not generally known. We are indebted for the information to Professor E. Renevier, of Lausanne,* who gathered them personally from the younger Sowerby.

Of the Scotch fossils described by these authors, those from the Lothians were forwarded to them by Dr Fleming, and those from the Closeburn limestone by C. Stuart Menteath, Esq., the proprietor of the quarries on that estate.

The species described, with their references and dates of publication, are:

Productus	*longispinus*	(J. Sby.),	vol. i., t. 68,	Oct. 1841.
"	*Flemingii*	"	"	"
"	*spinulosa*	"	"	"
"	*spinosa*	"	vol. i., t. 69,	"
"	*Scotica*	"	"	"
Nautilus	*bilobatus*	"	vol. iii., t. 249,	Oct. 1819.
"	*pentagonus*	"	"	"
"	*tuberculatus*	"	"	"
Orthoceras	*giganteum*	"	vol. iii., t. 246,	"
"	*cordiformis*	"	"	"
Conularia	*quadrisulcata*	"	vol. iii., t. 260,	April 1820.
"	*teres*	(J. Sby.),†	"	"
Productus	*lobatus*	"	vol. iv., t. 318,	Dec. 1821.
"	*costatus*	(J. de C. Sby.),	vol. vi., t. 560,	May 1827.
Leptæna	*distorta*	"	vol. vii., t. 615,	Oct. 1840.

During the publication of the "Mineral Conchology," the Rev. Dr Fleming published his "History of British Animals,"‡ at that time the most complete compendium of British Zoology. Fleming, who added much to our knowledge of Scotch fossils, gives brief descriptions of the species common throughout the British Islands. Frequent reference is made to the figures published by Ure, and several species were named after him by Fleming, who was, I believe, the first to identify many of Ure's drawings with the species created by other naturalists in the interim.

* Bull. des Séances de la Soc. Vaudoise des Sc. Nat., Lausanne, 1853-55, iv., pp. 318-320.

† Probably an *Orthoceras*.

‡ Pp. 565, 8vo, Edinburgh, 1828.

Fleming was born at Kirkroads, Bathgate, in Linlithgowshire, and it has been suggested by Mr John Gray, I think with justice, that Fleming in all probability obtained his first insight and encouragement in Natural Science from David Ure (or his writings), who was Minister of that parish about the time in question. Fleming's collection now rests in the Museum of Science and Art, Edinburgh, where I have on many occasions had an opportunity of consulting its riches through the kindness of my friends Professor T. C. Archer and Dr R. H. Traquair.

The twenty-three additions to the Scotch Carboniferous Mollusca made by Dr Fleming in the "British Animals" are as follows:

Lingula mytiloides	(Sby.)	= Ure, t. 16, f. 5.*
Terebratula sacculus	(Mart.)	„ f. 9.
Camarophoria crumena	„	„ 14, f. 6.
Spirifera excavata	(Flem.).	
„ *trigonalis*	(Martin)	= Ure, t. 15, f. 1.
„ *Urei*	(Fleming)	„ t. 14, f. 12.
Orthis resupinata	(Martin)	„ t. 14, f. 13 and 14.
Productus punctatus	„	„ t. 15, f. 7.
Pecten dissimilis	(Fleming).	
Nuculana attenuata	„	= Ure, t. 15, f. 5.
Nucula gibbosa	„	„ t. 15, f. 6.
Myalina crassa	„	
Unio Urei	„	= Ure, t. 16, f. 4.
Corbula limosa	„	
Allorisma sulcata	„	
Turritella Urei	„	= Ure, t. 14, f. 7.
Bellerophon decussatus	„	
„ *striatus*	„	
„ *apertus*	(Sby.).	
„ *cornuarietis*	„	
„ *Urei*	(Fleming)	= Ure, t. 14, f. 9.
Nautilus ingens	(Martin)	„ p. 307.
„ *quadratus*	(Fleming).	

* These are Fleming's identifications, and references to Ure's work.

In addition to these eleven species of *Orthoceras* were mentioned, which had, however, been previously described by Fleming.*

Ten years after the publication of the "British Animals," appeared a little work, entitled "The Age of the Earth, considered Geologically and Historically,"† by Mr William Rhind, at one time a President of our Society. In this are figured three bivalve shells from the "coal strata" at Woodhall, Water of Leith, and from the coal shale at Polmont, Falkirk. These shells are:

Axinus Pentlandicus (Rhind),		Woodhall.
Modiola,	1 species,	"
Unio,	3 "	Polmont.

Mr Rhind was a member of the Royal College of Surgeons of Edinburgh, and the author of two other works on Geology.

An attempt to bring together in one volume the whole fossil conchology of any given country, both descriptive and illustrative, cannot but commend itself to our warmest sympathies. A task so gigantic would, at the present time, be nigh impossible, but in 1849, when Sowerby's "Mineral Conchology" had been discontinued for three years, it was accomplished by Captain T. Brown. His "Illustrations of the Fossil Conchology of Great Britain and Ireland"‡ will always remain a monument of his industry, ability, and scientific acumen. In this book are given a brief description and figure of all the fossil shells known to the author at that time. One omission detracts greatly from the value of the "Illustrations," viz., the absence of all reference to Professor M'Coy's valuable work, "Synopsis of the Carboniferous Limestone Fossils of Ireland," published in 1844.

Thomas Brown, Captain in the Forfar Regiment, was President of this Society about 1831 and 1832, a member of the old Wernerian Society, and at one time, during a residence in Manchester, curator of the Museum of the Literary and Philosophical Society of that town.

* Thomson's Ann. Phil., 1815, v., p. 199.
† Pp. 202, 12mo, Edinburgh, 1838.
‡ Pp. 273, pls. 98, 4to, London, 1849.

The "Fossil Conchology" is chiefly useful to Scotch Palæontologists for the list of shells from the Closeburn limestone in Dumfriesshire. The fossils, as in the case of those described by J. Sowerby, were collected by Mr C. S. Menteith.

Omitting the names of fossils previously described from Scotch localities by the Sowerbys or Fleming, the following are Captain Brown's twelve additions to the list:

Orthoceras cinctum	(Sby.),	Closeburn.
Spirifera glabra	(Martin),	Arran.
„ *lata*	(Brown),	„
Productus Martini	(Sby.),	„
„ *latissimus*	„	„
„ *giganteus*	„	Fife.
Avicula modioliforme	(Brown),	Woodhall.
Unio Gerardi	„	Dalkeith.
„ *Rhindii*	„	Polmont.
„ *nucleus*	„	Woodhall.
„ *pyramidalus*	„	„
„ *polmontensis*	„	Polmont.

We had occasion, when dealing with the Silurian shells of Scotland, to refer to M'Coy's great work on "The British Palæozoic Fossils." The third "Fasciculus,"* published in 1855, has the merit of giving the first detailed and scientific description of many species of shells collected from Scotch Carboniferous rocks; many localities are likewise mentioned.

In 1857 a new era for British Carboniferous Palæontology was ushered in by the appearance of the first part of Mr Davidson's "Monograph of the British Carboniferous Brachiopoda."† It comprises five sub-parts, and was published between the years 1857-63, containing fifty-five lithographic plates all executed by the author in his usually accurate and graphic style. It contains an excellent table, showing the geographical distribution of the British Carboniferous Brachiopoda. Almost concurrently with the monograph, Mr Davidson wrote a lengthy paper for the "Geologist"‡ on

* Pp. 407-644. † Pp. 280, pls. 55, 4to, London, 1857-63.

‡ Geologist, 1859, ii., p. 461; 1860, iii., pp. 14, 99, 179, and 219.

"The Carboniferous System in Scotland, characterised by its Brachiopoda." It appeared in two successive volumes, and was afterwards separately published as a small book. Mr Davidson here gives descriptions with copious notes and remarks on the then known species of Carboniferous Brachiopoda, which, as researches went on, were increased at the time of completion of the "Monograph" to fifty.

During last year this indefatigable writer contributed a supplement to his work, forming part 3 of vol. iv. of "The British Fossil Brachiopoda," with eight additional plates devoted to Carboniferous species. The number of species through recent discoveries, has been slightly increased, the total now standing at 59 or 60, distributed throughout the sub-divisions of the Carboniferous system in Scotland, thus:

Coal Measures, . .	2 to 4	species.
Millstone Grit, . .	11	„
Up. Limestone Group, .	45 to 46	„
Edge Coal Group, . .	9 to 10	„
L. Limestone Group, .	59 to 60	„
Calciferous Sandstone Series,	23 to 24	„

In the gigantic task thus brought to a successful termination Mr Davidson has had the assistance of a large staff of local collectors and observers. It is perhaps invidious to mention one name more than another, but as regards those resident in Scotland, the following gentlemen should be recalled to mind:

From Lanarkshire localities, specimens have been extensively collected by Messrs J. Armstrong, J. Bennie, Dr J. S. Hunter, and R. Slimon; from Stirlingshire, by Mr J. Young F.G.S.; from Renfrewshire and Dumbartonshire, by Messrs Armstrong, J. Thomson, and J. Neilson, jun.; the county of Ayr has been well searched by many of the preceding collectors, and of late more particularly by Messrs R. Craig, of Beith, and J. Smith, of Kilwinning. The collections from the Lothians and Fife were originally made for Mr Davidson by the late Rev. Dr Fleming and Hugh Miller, supplemented

of recent years by the assistance of Messrs A. Sommervail (late of Edinburgh), J. Henderson, and D. J. Brown. The collections of the Geological Survey, made by Messrs J. Bennie and A. Macconochie, have lastly afforded some interesting material for Mr Davidson's examination.

In former pages reference has been made to the "Explanations of the Geological Survey of Scotland." They claim our attention as having contributed in a lesser degree to the elucidation of Scotch Fossil Conchology. They are officially regarded as a description of the maps published on the scale of one inch to a mile, pending the publication of more detailed memoirs, descriptive of districts and mineral fields. The palæontological portion is confined to an Appendix giving lists of the fossils collected, and in some cases a few descriptions of particularly interesting forms.

The first Survey publication to appear relating to Scotland was the Memoir No. 32, embracing the neighbourhood of Edinburgh, the Pentland and Bathgate Hills, and a small corner of Fifeshire. The fossils from this district were collected by the late Messrs R. Gibbs and W. Rhind, and the list drawn up by Mr J. W. Salter, comprising Brachiopoda, 31 sp.; Bivalves, 9 sp.; Gasteropoda, 10 sp.; Cephalopoda, 11 sp.; and Pteropoda, 1 sp.

Memoir 33, containing the "Geology of East Lothian,"* and Memoir 34, "Geology of Eastern Berwickshire,"† succeeded the foregoing, and in both full lists of fossils from the south-eastern counties of Scotland are given. In 1871 appeared the Explanation of Sheet 15, embracing portions of Dumfries, Lanark, and Ayr shires, followed in due course by Explanation 22,‡ Explanation 23,§ and Explanation 31.||

In 1871 appeared the most important general communication published up to that date, bearing on the Carboniferous fossils of Scotland, particularly the west, viz., "The Car-

* Pp. 77, 8vo, 1866. † Pp. 58, 8vo, 1864.

‡ North part of Ayrshire, 8vo, 1872. § Central Lanarkshire, 8vo, 1873.

|| South Stirlingshire, North Lanarkshire, and West Linlithgowshire, 8vo, 1879.

boniferous Fossils of the West of Scotland, their Vertical Range and Distribution, with General Catalogue of the Fossils, their Mode of Occurrence, and an Index to the Principal Localities."* This catalogue, with its important mass of facts, by Messrs Armstrong and Young, first appeared in the *Transactions* of the Glasgow Geological Society,† but was afterwards published separately as above.

The "Glasgow Catalogue," as it is usually called, may be said to have formed the basis of another list we have already had occasion to notice when dealing with the Silurian shells—"The Catalogue of Western Scottish Fossils." The remarks then made are applicable here, only adding that the Carboniferous portion is even more complete in its details than the Silurian.

The following is the census of Carboniferous Fossils found in the west and west-central districts of Scotland, as then computed by Messrs Armstrong and Young:

Brachiopoda, . .	15 genera, . .	52 species.
Bivalves, . .	29 „ . .	155 „
Univalves, . .	15 „ . .	87 „
Pteropoda, . .	1 „ . .	1 „
Cephalopoda, . .	6 „ . .	46 „
Total, .	66 genera.	341 species.

Although not directly and simply devoted to the Palæontology of Scotland, but as bearing on it, may be mentioned in conclusion the "*Thesaurus Devonico-Carboniferus*,"‡ by the late Dr J. J. Bigsby, F.R.S. This work (with its companion the "*Thesaurus Siluricus*") represents one of the most painstaking pieces of geological research extant in the English language. In it is given a census of the whole world-wide fauna of the Devonian and Carboniferous rocks. The range in time of each species is shown, and a few of the chief localities given; the fossils of the Scotch Carboniferous system naturally receive due attention.

The BRACHIOPODA is the most important class of the

* Pp. 103, 8vo, Glasgow, 1871.

† Vol. iii., Appendix.

‡ Pp. 447, 4to, London, 1878.

Mollusca in the Carboniferous Limestone series, having assisted in the formation of many of the bands of limestone into which that formation is split up in Scotland. For instance, Mr R. Craig states that some of the upper limestones of the Lower Carboniferous Limestone Group in the Dalry district are almost built up of the remains of *Productus, Spirifer,* and *Terebratula.**

The Brachiopoda further possess, through the eminent services of Mr T. Davidson, F.R.S., the advantage of long and continuous investigation into their structure and distribution.

At present some sixteen or seventeen genera, and about fifty-nine or sixty species have been described from Scotch localities, as compared with one hundred and seventeen species in the English, and eighty-four in the Irish Carboniferous limestone.†

Brachiopoda grow continuously less and less plentiful as we ascend in the Carboniferous series. This holds good both in England and Scotland. They flourished essentially during the deposition of the Carboniferous Limestone and its accompanying shales.‡

Of the fifty-nine species several are now known to pass upwards into the Permian system of England. It is a point of much interest to watch day by day the increased number of forms which Palæontology indicates as common to the two formations.

Although some of the Scotch Brachiopods vie in size with specimens from the thick masses of limestone in other parts of the British Islands, the individuals found in Scotch beds, are, as a general rule, much dwarfed in size, but frequently more perfectly preserved. This is probably to be accounted for by less favourable conditions of existence.§

All the genera found in the west of Scotland are met with

* "On the Fossils of the Upper Series of the Lower Carboniferous Limestones in the Beith and Dalry Districts of North Ayrshire" (Trans. Geol. Soc., Glasgow, 1879, vi., pt. 1, p. 4).

† I am under obligations to Mr Davidson for these details.

‡ Davidson, Carb. Mon., 1857, p. 3.

§ Davidson, Geologist, 1860, iii., p. 237; Young and Armstrong, Catalogue, p. 36; Somervail, Trans. Geol. Soc., Edinb., 1877, iii., p. 79.

in the limestones and shales of the East, but the number of species is less.* The latest computation places these at from fifty-three to fifty-four. The district which appears to have yielded the greatest number and variety of Brachiopoda in Scotland is that of Campsie, where forty-three have been found.† Brachiopoda often appear to be the first to make their appearance in any given series of strata, if we may judge by the position of their remains in the beds in which they are found; equally so they are one of the latest classes to disappear in point of time. As an illustration of this we may adduce the case of *Discina nitida* (Phill.). A variety of this shell occurs in abundance low down in the Calciferous Sandstone series, in a marine band in the Wardie shales, at Woodhall, on the Water of Leith.‡ The same species is one of the shells met with in brown ironstone nodules some 60 fathoms above the Ell coal in the true Coal Measures, and not far from the top of the Carboniferous system in Scotland.§

The abundance or rarity of Brachiopoda appears to be quite a local matter, and to follow no general rule. Either of these phenomena is probably due to suitable or unsuitable deposits acting as a sea bottom, food, temperature, and currents. In some parts of Lanarkshire, for instance, the genus *Productus* so outnumbers every other form of Mollusca in certain beds of the Lower Limestone Group, as to confer on them the name of the so-and-so *Productus* limestones, according to the species represented therein. Beds of coral (of the genus *Lithostrotion*, etc.) seem to have abounded in Brachiopod life. For instance, at Aberlady Bay, Haddingtonshire, portions of the beach are wholly composed of such a reef teeming with two species in particular, *Athyris ambigua* and *Rhynchonella pleurodon*. In the Upper Limestone Group, one of the lowermost limestones, known as the Index, is in a great measure composed of the remains of *Productus*

* Somervail, Trans. Geol. Soc., Edinb., 1877, p. 97.

† Young, "On the various Genera and Species of Brachiopod Shells found in the Main Limestone of the Campsie Valley" (Trans. Glasgow Nat. Hist. Soc., 1864, i., p. 95).

‡ Etheridge, Quart. Jour. Geol. Soc., 1878, xxxiv., p. 24.

§ Skipsey, Trans. Glasgow Geol. Soc., ii., 1865, pt. 1, p. 52.

*latissimus,** and forms from this circumstance a good horizon for surveying purposes. This bed is well displayed at Joppa quarry, near Edinburgh, and also on the banks of the North Esk river, at Valleyfield, near Penicuik. Again in the shale above the Hosie lime at Campsie a small *Chonetes* was found in millions by Mr John Young, and believed to be a variety of the common Carboniferous species.†

Attention has of late been directed to the collecting of the youngest possible stages of the species found in Scotland, the specimens varying from the size of a pin's head to that of one or two lines in diameter. Such investigations have been chiefly carried out by Messrs R. Craig, of Beith, and J. Neilson, jun., of Glasgow.

Certain beds in the Lower Limestone group of Ayrshire are particularly noticeable for their yield of these small Brachiopoda. For instance, at Dockra quarry, Mr Neilson states "that these little shells constitute the chief feature of the deposit there, indeed hundreds of specimens may be collected from one teaspoonful of the washed material."‡ Another interesting point connected with this subject has been noticed by Mr Craig, in the abundance of young examples in a certain deposit, and the comparative absence of the mature shells of the same species from the bed.§

Many Carboniferous Brachiopods appear to pass through endless varieties, a good example being the common *Spirifera trigonalis.* A very interesting paper has been written by Mr J. Young on this subject, "Notes on the Occurrence and Distribution of *Spirifera trigonalis,* and its varieties in the Limestone Strata of the Coalfields of the West of Scotland."|| Mr Young considers that the large number of varieties thrown off by the typical form are probably produced by descent from one original type. *S. trigonalis* commences to show itself in the lowest marine bed of the Carboniferous limestone, and ranges upwards to the millstone grit. Further-

* Mem. Geol. Survey, Scotl., Expl. 23, 1873, p. 82.

† Davidson, Mon. Carb. Brach., p. 187.

‡ Davidson, Suppl. Carb. Mon., 1880, p. 264.

§ *Ibid.*

|| Proc. Nat. Hist. Soc., Glasgow, 1876, iii., pt. 1, p. 37.

more, certain varieties are peculiar to certain horizons, the best example of this being, perhaps, a variety near *S. mosquensis* (Fischer), which is found in the shale overlying the cement limestone at Orchard quarry, near Glasgow, and nowhere else. Another species, which well displays the varietal tendency of Brachiopoda, is *Productus semireticulatus*, of which three or four well-marked varieties are present in the Carboniferous rocks of Scotland.

Perhaps one of the best examples of the continuity of a species throughout the Palæozoic rocks is exemplified by *Strophomena rhomboidalis* (Wahl.). This shell is first met with in British strata in the Caradoc, passes upwards through the Devonian, and terminates its life-range in the Carboniferous, where it is represented by the variety *analoga* (Phill.). The identity of this species throughout this great vertical thickness of strata was first pointed out by Professor L. G. de Koninck.* Its geological range is only equalled by its geographical distribution, for we have the same shell of one variety or another from the British, Continental, American, and Australian Palæozoic rocks.

As an example of the geographical distribution of a Carboniferous Brachiopod found in Scotland, of large size and common occurrence, we may cite *Streptorhynchus crenistria* (Phill.). It has been met with at a similar horizon in India, America, and Australia, and what is of especial interest the most peculiar variety *senilis* has lately been found by Mr R. L. Jack in the uppermost Carboniferous (perhaps Permo-Carboniferous) deposits of Queensland.†

We have already referred to the dwarfed nature of the Scotch Brachiopoda generally. Some species, however, do not conform to this, notably many *Producti* and *Streptorhynchus crenistria*. The former has been known to reach a size of 5½ inches by 9 or 10 in width, and in the English limestones somewhat larger.‡ The first mention of this shell we know of is by Ure,§ who refers to it as one of his *Anomiæ echinatæ*. He states, "The specimens are 5 or 6 inches in

* Rech. Foss. Terr. Carb., Belgique, p. 215.

† Etheridge, Proc. Roy. Phys. Soc., Edinb., 1880, p. 282.

‡ Davidson, Geologist, iii., p. 107.

§ History of Rutherglen, p. 316.

length, and of a corresponding breadth and thickness. . . . By workmen they are called limestone oysters. I have seen beautiful specimens of this shell in a quarry near Bathgate." I believe this name is still in use for *P. giganteus* in certain parts of the country. Again, in 1839, a Mr R. Craig found examples in the Lanarkshire lower limestones with a diameter of 5 or 6 inches.*

Streptorhynchus crenistria nowhere occurs in such quantity or of so large a size as in Scotland. Mr Davidson records one 3 inches long, by 4½ inches wide.† *Lingula squamiformis* also grows to a large size occasionally. This is the case in the Lower Blackband ironstone at Possil, where it occurs in great profusion.‡ It attains a similar size and profusion of numbers in the Edge Coal series of the Bo'ness coalfield.

As a last example, we may mention a newly-discovered shell, *Discina Craigii* (Davidson), which Mr J. Neilson has found in the cutting of the City of Glasgow Union Railway as much as 1¾ inches across.§

Many interesting facts have of late been brought to light in connection with the perforation of the shell substance, its prolongation into spines, their nature and use, etc. It would take us too long to enter into this subject in detail, and we can only refer those interested to Mr Davidson's "Supplementary Monograph," where the various modifications of structure have been thoroughly described. We may, however, mention the following species as presenting, perhaps, the chief modifications of spine structure: *Spirifera Urii* (Fleming), *S. lineata* (Martin) (a particularly noticeable modification from the recent discoveries of Mr John Young), *Productus semireticulatus* (Martin), *P. punctatus* (Martin), *P. complectens* (Eth.), *Athyris Roysii* (Léveille), and *A. lamellosa.*

The spinose investment of *Productus punctatus* was long ago noticed by old David Ure, who figured the shell as

* Trans. Highland Soc., 1839, vi., p. 361.

† Geologist, p. 104, t. 1, f. 7.

‡ Young, "Notes on the Occurrence and Range of Lingula in the Carboniferous Series of the West of Scotland" (Trans. Geol. Soc., Glasgow, 1866, ii., pt. 2, p. 144).

§ Trans. Geol. Soc., Glasgow, 1877, v., pt. 2, p. 227.

*Conchiæ pilosæ.** He says it is covered with "small spines resembling hair, and so numerous that a large example contains upwards of 10,000." The detached spines of the larger forms of *Productus* were probably the objects on which the genus *Arbusculites* was founded by Dr P. Murray, described as "very delicate vermiform bodies, in fragments of different lengths, shining with metallic lustre, neither articulated nor cellular, and resembling broken bits of silver wire." †

The British Carboniferous BIVALVES (*Lamellibranchiata*, *Pelycipoda*, or *Conchifera* as they are sometimes called) have not been studied to anything like the extent the Brachiopoda have. A sufficiently disinterested worker like Mr Davidson has yet to come forward, and undertake the elucidation of this important and difficult class. In the specific determination of these shells we are dependent almost solely on two or three works. Phillips' "Illustrations of the Geology of Yorkshire," ‡ M'Coy's "British Palæozoic Fossils," § and the "Synopsis of the Carboniferous Limestone Fossils of Ireland," ‖ by the same author. The first of these works may be said to be practically obsolete, the third is in sad need of revision and correction; whilst the second, extremely good so far as it goes, does not encompass the subject sufficiently for the practical purposes of the Palæontologist. Not only are individual works on our Carboniferous Bivalve Shells wanting, but even papers and memoirs in the publications of scientific societies are of the most meagre description. In fact, this branch of the Palæozoic Mollusca generally is in a similar state of chaos to the Brachiopoda, when their study was first undertaken by Mr Davidson. There is really more good work to be done amongst these shells and the Univalves than in any other group of fossil organic remains known to us.

* History of Rutherglen, etc., p. 316, t, 15, f. 7.

† "Account of the *Arbusculites argentea* from the Carboniferous Limestone of Inverteil, near to Kirkcaldy in Fifeshire" (Edin. N. Phil. Jour., 1831, xi., p. 147).

‡ Pt. 2. The Mountain Limestone District, 4to, London, 1836.

§ Fasciculus 3, 4to, Cambridge, 1853.

‖ 4to, Dublin, 1844.

The so-called division of the *Monomyaria* are confined to the marine limestones, the *Aviculopectinidæ* being the most abundant and widely distributed group. The *Dimyaria* are divisible into two sections—one, comprising the truly marine forms is confined to the Carboniferous Limestone strata, the other or brackish water division, consisting of such shells as *Anthracosia* and *Anthracoptera*, etc., is to be found in the Coal Measures and other brackish or fresh water strata.*

The Carboniferous Bivalves do not enter into the composition of the limestones in anything at all approaching the abundance of the Brachiopoda,† but appear to have, in a great degree, confined their habitat to the more argillaceous deposits of the period. The marine species "are met with in greatest numbers in the shales and clay ironstones that alternate with the limestone." ‡

Casts of the interior of the valves, or specimens from which the external shell has been dissolved away by chemical action, should be eagerly sought; for, on the study of these, and facts revealed by their study, will depend the entire future classification of the group.

The family *Ostreidæ* is not satisfactorily established in Scotch Carboniferous rocks, § although it is represented in Ireland by an *Anomia*,‖ in Belgian beds by a true oyster,¶ and in the American Sub-Carboniferous by a shell which has been so referred.**

Formerly the *Pectinidæ* were united with the *Ostreidæ*, but by many good authorities they are separated as a distinct family.†† Further, Messrs Meek and Hayden have

* Armstrong and Young, Catalogue, p. 44.

† Craig, Trans. Geol. Soc., Glasgow, vi., pt. 1, p. 6.

‡ Armstrong and Young, Cat. W. Scot. Foss., p. 50.

§ I am not prepared to maintain the identity of the shell I some years ago called *Anomia antiqua*, M'Coy (Mem. Geol. Survey, Scotl., Expl. 22, p. 38).

‖ *A. antiqua*, M'Coy (Synopsis, 1844, t. 19, f. 7).

¶ *Ostrea nobilissima*, De Koninck (Foss. Terr. Carb. Belgique, Suppl., 1851, p. 680, t. 57, f. 1).

** *O. patercula*, Winchell (Proc. Acad. Nat. Science, Philadelphia, 1865, p. 124).

†† Stoliczka, Mem. Geol. Survey, India, 1871, iii., p. 423.

subdivided the *Pectinidæ* into two sections,* which I believe must be accepted—thus:

a. Pectinidæ, or "scallop shells" proper—with a large anterior ear, and central cartilage pit.

b. Aviculopectinidæ—large posterior ear, no cartilage pit, but a grooved hinge area.

It is quite possible that the typical genus *Pecten* occurs in British Carboniferous rocks; indeed, Professor M'Coy has so referred one species.† Be this as it may, however, we undoubtedly have a member of the *Pectinidæ* proper, and one which is pretty extensively found in Scotland—the *Entolium Sowerbii* (M'Coy, sp.).‡ This shell has been variously referred to at different times, but a fortunate discovery by Mr Bennie of many well-preserved internal casts at Teasses Quarry, Fife, enabled its affinity with Meek's genus *Entolium* to be made out.§ Great interest is attached to *E. Sowerbii*, from the evident manner in which it forecasts an Oolitic type, represented by the *Pecten demissum* (Phill.). A few years ago Mr Bennie found a badly preserved shell in the east of Scotland with all the appearance of an ordinary *Aviculopecten*. The hinge line, however, bore traces of a series of hinge pits rather than the usual striated area. Two genera possessing this character have been described from American Carboniferous rocks — *Pernopecten* (Winchell)‖ and *Euchondria* (Meek),¶ to either of which the shell in question may be referred so far as we know its structure.

The genus *Aviculopecten* is certainly the most prolific genus of Bivalves in the Carboniferous system. No less than 44 species have been listed from Scotch Carboniferous rocks, but it is not too much to say that quite a quarter of these have no existence, in fact, being mere synonyms of one

* Pal. Up. Missouri, 1864, p. 48.

† Brit. Pal. Foss., p. 477.

‡ M'Coy, Synopsis Carb. Foss., 1844, p. 100; Etheridge, Geol. Mag., 1874, i., p. 300; 1877, iv., p. 241.

§ Etheridge, "On the Hinge Structure and Generic Affinities of *Pecten Sowerbii*," etc. (Annals Nat. Hist., 1878, ii., p. 30).

‖ Proc. Acad. Nat. Science, Philad., 1865, p. 125.

¶ American Jour. Science, 1874, vii., p. 445.

another. At the same time there are other genuine species in our beds which have never been described.

These so-called species have, with few exceptions, been placed haphazard in the genus *Aviculopecten*, simply from their general resemblance to M'Coy's type. It is, however, possible, and even probable, that many of them may belong to types, at least subgenerically distinct from *Aviculopecten*. We probably possess one *Pecten*, if not more; we certainly have an *Entolium*, and perhaps a *Euchondria* or *Pernopecten*. Lastly, I see no reason why the genus *Streblopteria*, proposed by Professor M'Coy,* should not be made more use of than it has been.

In England at least, two species of *Aviculopecten* occur in the Coal Measures,—*A. papyraceus* (Sby.), in the Gannister coal, near Oldham,† and *A. fibrillosus* (Salter), in a marine bed at Ashton-under-Lyne, over the great main seam.‡

Now, in Scotland, *A. papyraceus*, which is a typical Coal Measure species elsewhere, so far as I am aware, does not occur in the Coal Measures proper, but is confined to the limestones, and the Middle Coal and Iron series.§ A full list of the Scotch Aviculopectens will be found in both the "Catalogues" by Messrs Armstrong and Young, but space forbids our making anything like a descriptive reference to them.

The family Aviculidæ or Pteriidæ, as it is now usually called,‖ contains the genera *Avicula, Pterinea, Posidonomya, Myalina*, and *Pteronites*. The first and last of these genera are well represented by species in Scotch Carboniferous rocks, but do not call for detailed notice.

Myalina is an excellent genus possessing terminal beaks, a thickened flat hinge margin with longitudinal cartilage grooves, and sometimes septiferous beaks. As the British type we may select *Myalina crassa* (Fleming), a very gregarious shell, which sometimes grows to large proportions.¶ It

* Brit. Pal. Foss., p. 482.

† Mem. Geol. Survey, Gt. Britain, country around Oldham, 1864, p. 61.

‡ *Ibid.*, p. 64.

§ See Etheridge, Annals Nat. Hist., 1875, xv., p. 427

‖ *Ibid.*

¶ *Ibid.*

is very common at the typical locality, Cults, Fifeshire, where it may be gathered in large quantities. Formerly, *Myalina* was referred to the Mytilidæ, but Messrs Meek and Hayden have shown * the shell structure of American species to be prismatic, like that of the Aviculidæ and Dreissenidæ. This character added to the undoubted inequality of the valves and broad cardinal area, places the genus, they think, rather in the Aviculidæ than the Mytilidæ.

In the Uppermost Devonian and some portions of the Carboniferous the genus *Posidonomya* occurs of large size, but in the Carboniferous series of Scotland the species are small.

P. corrugata is one of those shells which attracts attention from the collector on account of its highly gregarious nature. It literally occurs in thousands at certain horizons, especially that of the Calderwood Cement-Stone in the Lower Limestone group of E. Kilbride.†

Pinna and its allies are now regarded as a separate family, and must in future be so considered. Very little appears to be known about the internal characters of the Carboniferous species referred to *Pinna*, but there certainly appears to be very little difference between *P. flabelliformis* (Martin), the common species, and those now in existence. Three or four species occur in Scotland, and in places are common; for instance, at Bogie quarry, near Kirkcaldy. At Bishopbriggs, in the representative of the Orchard Cement-Stone, Messrs Armstrong and Young have observed specimens of *Pinna* placed in an erect position, at right angles to the strata.‡

The Mytilidæ is represented by shells referred to the genus *Modiola*, and by the brackish water forms *Anthracoptera* and *Anthracomya*. One shell also has been placed in the genus *Mytilus*, and although not prepared to deny the presence of this genus in Palæozoic rocks, I yet believe the species usually called by this name

* Pal. Up. Missouri, p. 31.

† For detailed descriptions see Mem. Geol. Survey, Expl. 23, 1873, pp. 71 and 103; Geol. Mag., 1874, i., p. 304.

‡ Trans. Geol. Soc., Glasgow, 1877, v., pt. 2, p. 252.

will be found to differ more or less from the existing species.

Modiola is well represented by a large shell, *M. lithodomoides* (Etheridge),* which it is quite probable may turn out to be only the full-grown variety of *Modiola lingualis* (Phillips). Four other species, in addition to the two mentioned, occur in Scotch Carboniferous strata. Professor M'Coy has described a bivalve, with apparently all the characters of the recent *Lithodomus*, from the Carboniferous beds of Northumberland, and it is also found in the Lingula ironstone at Carluke.†

From their resemblance to the Dreissenidæ I believe it quite possible for *Anthracoptera* and *Anthracomya* to belong to this family rather than to the *Mytilidæ*. The two genera are almost entirely restricted to the brackish-water strata of the Carboniferous, the Coal Measures, the Middle Coal and Iron series, and portions of the Calciferous Sandstone series. In certain places they must have swarmed in great numbers, and with another genus, *Anthracosia*, have formed what are now moderately thick and compact beds. *Anthracoptera* in outline and form greatly resembles *Myalina*, but there is no trace of the striated hinge-plate of this genus, or in fact of any hinge-plate at all.‡ The genus was published by Dr Dawson, in Canada, under the name of *Naiadites*,§ on specimens obtained from the Coal Measures of the South Joggins, Nova Scotia. The affinity of these shells has been discussed by Dr Dawson at some length. He considers them to be brackish-water shells, allied to the *Mytilidæ*, or embryonic forms of Unionidæ, and states that the structure of the shell is similar to that of the latter family.|| There is an internal lamellar layer, a subnacreous layer of vertical prismatic shell, and an epidermis; an external ligament and a byssus. Dr Dawson concludes, "The mode of their occurrence precludes the idea that they were burrowers, but favours the

* "On some Undescribed Carboniferous Fossils" (Geol. Mag., 1875, ii., p. 241).

† Armstrong and Young, Cat. W. Scot. Foss., p. 54.

‡ Salter, Mem. Geol. Survey, Great Britain, Country around Wigan, 1862, p. 37.

§ Acadian Geology, p. 202. || *Ibid.*, p. 203.

belief that they were attached by a byssus to sunken or floating timber." * Conclusive and remarkable confirmation of this view has lately come under my notice. My colleague, Mr H. Woodward, LL.D., called my attention to a specimen of a plant resembling a *Calamite*, from the Millstone grit of Lancashire, compressed quite flat in shale, with a number of these *Anthracopteræ* so placed around the wood, that no other supposition than that of attachment by a byssus will account for their position.

A very characteristic species of the Middle Coal and Iron series occurs in the Bo'ness coalfield,† and is quite distinct from those of the English Coal Measures described by Mr J. de C. Sowerby. It is shorter, thicker, and with a greater convexity of valve.

The presence of *Anthracoptera* has now been pretty well demonstrated in the Wardie Shale group of the Calciferous Sandstone series,‡ through the collecting of Mr James Bennie and Mr J. Henderson. Throughout its distribution the genus retains its distinctively brackish or fresh-water habit, whilst the shells of certain of its species appear to have been a great habitat for the little tubicolar Annelide *Spirorbis*. The infested condition of such Mollusca by these little worms appears to have been pretty general, for they are found adhering to them both in the Lower Carboniferous of the Edinburgh district and Ayrshire.§

The systematic position of *Anthracomya* is less certain. To Salter, who established the genus,‖ its affinities were evidently a question of doubt, but I strongly suspect it cannot be very far removed from *Anthracoptera*. Only one species (as yet described) occurs in Scotch Carboniferous rocks. It is confined to the Coal Measures, and the Middle

* Acadian Geology, p. 203.

† *A. tumida* (Etheridge), Mem. Geol. Survey, Scotl., Expl. 31, p. 82.

‡ Etheridge, "On the Invertebrate Fauna of the L. Carboniferous Series of the Edinburgh Neighbourhood," etc. (Quart. Jour. Geol. Soc., 1878, xxxiv., p. 1).

§ J. Young, "On Organisms from the Calciferous, or Cement-stone Series lying at the base of the Carboniferous System in Ayrshire" (Proc. Glasgow Nat. Hist. Soc., 1878, iii., pt. 3, p. 328).

‖ Iron Ores of Great Britain, 1861, pt. 3, p. 229.

Coal and Iron series. I believe there is an undescribed one from the latter series of the Bo'ness coalfield, but I was never able to obtain other than crushed examples.

Of the Arcidæ but one genus is met with in the Carboniferous rocks of Scotland, *Arca* itself, comprising about five species. They do not call for detailed notice, but one fact may be referred to—the preponderance of Belgian species,* as against those of more purely British type. American Palæontologists now employ† the Jurassic genus *Macrodon* (Lycett) for the reception of their arciniform shells of the Carboniferous period. After examining the hinges of some European, as well as strictly British species, I think there may possibly be grounds for this, without, however, expressing a decided opinion.

The pretty and compact genus *Nucula* is the only Carboniferous member of the *Nuculidæ* we appear to possess. It is one of the richest in species after *Aviculopecten*, and contains several very interesting forms with regard to the morphology of the genus. The late Mr J. W. Salter proposed‡ the transfer of the Carboniferous *Nuculas* with the next genus *Nuculana* to his *Ctenodonta*, a group of Silurian shells with the characters of *Nucula*, but without a cartilage pit. Professor M'Coy, however, has described§ this important feature in the Carboniferous type of the genus, *N. gibbosa* (Fleming), but I do not know that a cartilage pit, accompanied by the usual hinge teeth, has been observed in any other species found in our Carboniferous rocks. The presence of *Ctenodonta* proper (or as it should perhaps be called *Tellinomya*, Hall) has yet to be proved in the latter. The Nuculidæ form a convenient family, distinguished from the following, or Nuculanidæ, by their much shorter form posteriorly, and entire pallial impression.‖

Nuculana, the representative genus of the family *Nuculanidæ* almost equals its ally *Nucula* in the number of species

* Armstrong and Young, Cat. W. Scot. Foss., p. 53.

† Miller, Cat. American Pal. Foss., p. 194.

‡ Mems. Geol. Survey, 1866, iii., p. 345; Iron Ores of Great Britain, pt. 3, 1861, p. 221.

§ Brit. Pal. Foss., p. 512.

‖ Stoliczka, Mem. Geol. Survey, India, iii., p. 325.

found in our rocks of Carboniferous age. The most abundant and very characteristic species, *N. attenuata* (Fleming, sp.), like *Nucula gibbosa*, possesses a well-defined cartilage pit immediately under the beaks,* and like it, therefore, cannot be absorbed in *Ctenodonta* (Salter). The name *Leda*, proposed by Schumacher in 1817 has been in use for this particular group of shells for many years; but several authors, including the late Dr Stoliczka † and Messrs Meek and Hayden, ‡ have shown that *Nuculana* (Link), published in 1807, has precedence, and should be used in its place. The latter authors have also pointed out the possibility of *Yoldia* (Muller) being a Carboniferous genus. It is distinguished from *Nuculana* by having a deeper pallial sinus, and less prominent beaks. The Carboniferous shells, which especially assume the outline of *Yoldia*, are *N. clavata* (M'Coy) § and *N. intermedia* (Eth.). ||

The extensive secondary genus *Trigonia* (Family *Trigoniidæ*) is represented in Carboniferous rocks by *Schizodus* (King), which many writers have confounded with *Axinus* (Sowerby). The latter genus, as very justly pointed out by Professor W. King,¶ was typified by a shell from the London clay (Eocene), but Sowerby united with it certain Permian forms. The latter constitute King's *Schizodus*, and are quite distinct from Sowerby's *Axinus*. Professor M'Coy,** on the other hand, united *Schizodus* with Brown's *Myophoria*; but, although undoubtedly allied to this, I think, with Meek and Hayden,†† that it is preferable to retain the smooth and non-plicate Palæozoic shells distinct from the true *Myophoriæ* of the secondary rocks.

In Scotland the *Schizodi* occur in the Carboniferous Limestone, but in England their chief development appears to have been in marine beds of the Coal Measures. A somewhat similar habitat is assumed by them in the Calciferous Sandstone Series of Scotland, for along the south-east coast, where

* Etheridge, Annals Nat. Hist., 1878, ii., t. 1, f. 6 and 7.
† Mem. Geol. Survey, India, iii., p. 319. ‡ Pal. Up. Missouri, p. 60.
§ Synop. Carb. Lime. Foss., Ireland, 1844, p. 11, f. 25.
|| Geol. Mag., 1873, x., t. 12, f. 3.
¶ Permian Foss., England, 1851, p. 185. ** Brit. Pal. Foss., p. 494.
†† Pal. Up. Missouri, p. 58.

these beds are largely developed, we find *Schizodi* in gregarious masses, forming complete beds.*

Phillips' Family *Solemyidæ* appears to have extended as far back as the Carboniferous period, if we may judge from a shell having all the appearance of the genus *Solemya* (Lamarck). This was first pointed out by the late Professor Phillips, who described the only species, *S. primæva.*† The resemblance of the internal details of the Carboniferous fossil to those of the recent shell was afterwards shown by Professor W. King.‡ A shell, referred to the genus *Sanguinolites* (*S. radiatus*, M'Coy §), probably forms a second species.

We now come to a very important group of Bivalves, comprised in the genus *Anthracosia*, and exclusively confined to the true Coal Measures, unless a doubtful shell described by Captain T. Brown from the Wardie shales, at Woodhall, belongs to it. ‖ *Anthracosia* has usually been placed in the Family Unionidæ, but the late Mr Salter, who extensively studied this group of shells, has thrown doubts on the propriety of such a reference. Mr Salter believed *Anthracosia* to be a burrower, after the habit of *Mya*. He says, "among beds where these fossils were the only bivalves, I have seen bivalve-burrows answering to them in size." ¶ These are met with at Craig Hartle, in Fife.** But no distinct evidence has yet been procured, so far as I know, of such a habit in this genus. The evidence we at present possess appears to oscillate the genus between the Unionidæ and the Myadæ. I do not at present see any reason for placing it with *Saxicava*, as has been done by Dr Stoliczka.†† *Anthracosia* was in all probability not a purely freshwater genus, but of brackish water habit, for according to the researches of Salter, supple-

* Rev. J. Brown, Trans. Roy. Soc., Edinb., xxii., 1861, p. 393

† Geol. Yorkshire, 1836, ii., p. 209.

‡ Mon. Permian Foss., pp. 177 and 246.

§ Synopsis, 1844, t. 13, f. 14.

‖ Foss. Conchol. Gt. Brit., 1849, p. 178, t. 73, f. 8; Rhind, Age of the Earth, 1836, pl. 2, f. *a*; Etheridge, Quart. Jour. Geol. Soc., 1878, xxiv., p. 16.

¶ Iron Ores, p. 226.

** Etheridge, Expl. 23, p. 104.

†† Mem. Geol. Survey, India, iii., p. 81.

mented by those of Mr E. W. Binney and Professor E. Hull, it is often associated with true marine forms.*

The great abundance in which *Anthracosia* occurred in the true Coal Measures is nowhere better shown than in the Cambuslang marble, which is a bed of some thickness chiefly composed of shells of this genus.† No less than twelve species are said to occur in the Coal Measures of Scotland, but doubtless much revision is required here.‡

In the Family *Cardiidæ* has been placed perhaps the most peculiar shell of the Carboniferous period—the genus *Conocardium* (Bronn). It is better known in this country as *Pleurohynchus* (Phillips), but the former has priority of date. The hinge structure is not thoroughly known, and would afford a very interesting study. *Conocardium* has been placed in the aberrant group *Rudista*, and, although this is probably too extreme a reference, it still remains doubtful if it is a true member of the *Cardiidæ*.§ Internally the shell of *Conocardium* is strengthened by ribs, which appear to vary according to species.

The Family *Cyprinidæ*, or as it is called by some the *Glossidæ*, is represented by shells placed in the genus *Cypricardia* (Lamarck), but which I am not at all clear possess the hinge structure of the latter as presented to us in the living shells. The Carboniferous species are of great interest as exhibiting some peculiar modifications of form. Two such have been ably described by Mr James Armstrong ‖ from Scotch rocks of that age—*C. acuticarinata* and *C. crebricostata*. Another of the so-called *Cypricardiæ* is probably referable to King's genus *Pleurophorus*,¶ and it is possible that the latter may

* Salter, Iron Ores, p. 227.

† J. Young, "On the Fossil shells *Anthracosia*, *Anthracomya*, and *Anthracoptera*, found in the Lanarkshire Coalfield" (Proc. Nat. Hist. Soc., Glasgow, 1864, i., p. 84).

‡ Armstrong and Young, Cat. W. Scot. Foss., p. 52; Brown, Foss. Conchol., 1849, p. 177; *id.* "Description of some New Species of the Genus *Pachyodon*" (Annals Nat. Hist., 1843, viii., pp. 390-396).

§ Meek and Hayden, Pal. Up. Missouri, p. 97.

‖ "Descriptions of Two New Species of *Cypricardia* from the Carboniferous Limestone of Lanarkshire" (Trans. Glasgow Geol. Soc., 1865, ii., pt. 1, p. 28).

¶ Mon. Perm. Foss., 1850, p. 180.

belong to this family with *Cypricardia*. It is an oblong, very inequilateral genus, with large hinge teeth, an external cartilage, and is posteriorly radiated on the exterior. One species, the *Cypricardia? tricostata* (Portlock),* has been described.†

Although no true *Solen* is known from Scotch Carboniferous rocks, the family is represented by a single small genus called *Solenopsis* by M'Coy. Detailed investigation will probably increase the number of these small solenoid shells, as I have reason to believe one or two occur in marine bands in the Calciferous Sandstone Series of the east of Scotland.

The last family of Carboniferous Bivalve shells which calls for any notice is the most numerous in genera—the Anatinidæ, containing the important genera *Cardiomorpha* (De Koninck), *Edmondia* (De Koninck), *Leptodomus* (M'Coy), *Allorisma* (King), and *Sanguinolites* (M'Coy).

The first of these comprises *Isocardia*-shaped shells with an edentulous hinge, which did not survive the Carboniferous period. Professor M'Coy instituted a genus in 1844 without description, which he called *Isoculia*. This is believed by Dr Stoliczka to be identical with *Cardiomorpha*. It will in noway affect the stability of De Koninck's genus. It is probably one of the best defined of the whole group, for otherwise much confusion exists in the limitation of these genera. We cannot hope for a more satisfactory solution of this group, one of the most important of Carboniferous Bivalves, until the whole of the species shall have been examined collectively, and relegated to their proper genera.

The genus *Leptodomus* was published by Professor M'Coy in 1844,‡ and comprised a group of shells totally differing from that to which the name was applied in the second or third fasciculus of his later work, "The British Palæozoic Fossils." § Representatives of both these occur in the Carboniferous rocks of Scotland—the first by *Leptodomus fragilis*, is considered to be probably identical with De Koninck's *Cardio-*

* Geol. Report, Londonderry, 1843, p. 441.

† King, Perm. Foss., p. 164, Note 3.

‡ Synop. Carb. Lime. Foss., Ireland, p. 66.

§ Pp. 227 and 568.

morpha, by Dr Stoliczka,* and with another genus of M'Coy, *Sedgwickia*, by the late Dr S. P. Woodward.† The second group, typified by *L. costellatus*, Dr Stoliczka thinks may be identical with *Plectomya* of Loriol.‡ Whatever may be the eventual designation of the last species, the name *Leptodomus* must, if retained, be applied as *originally* defined by M'Coy. If distinct from *Sedgwickia*, it must be used in this sense; if identical, the name may then justifiably be transferred to the *L. costellatus* section, provided further researches show this shell to be distinct from any other previously described genus.

In the limitation of the three next genera great confusion exists. This is owing to the misapprehension of structure on the part of one or other of their authors, aided by an almost identical date of publication, by which they were not acquainted with the works of one another. *Edmondia* (De Koninck) is the best defined and most reliable. It is a transversely-oval, equivalve, edentulous shell, with an internal lamellar cartilage support. The dorsal margins are erect and simple, and the pallial line entire. As typified by *E. unioniformis* (Phill.) it forms a fitting receptacle for many Carboniferous Bivalves. Professor W. King has instituted a separate family for this genus, the Edmondiidæ.

The most perplexing of these genera is *Sanguinolites* (M'Coy), which, if sufficiently restricted, will be found to embrace many well-marked shells. At present it is a neterogenous assemblage of such species, others referable to *Edmondia*, and some appertaining to the next to be noticed, *Allorisma*.§ *Sanguinolites* was described in 1844,‖ on the type of Phillips' *Sanguinolaria angustata*, but the original example of this, in the Gilbertson Collection, is in so bad a state of preservation, that it will be next to impossible to say what is, or is not *Sanguinolites*, as typified by it. The shells to which the name will probably have to be restricted, are traversely oblong and equivalve, but very inequilateral, possessing an external ligament, and a strong external oblique posterior ridge. The pallial impression is entire.

* Pal. Indica, p. 270. † Man. Mollusca, p. 322. ‡ *Loc. cit.*, p. 66.
§ King, Mon. Perm. Foss., p. 164. ‖ M'Coy, Synopsis, p. 47.

Touching the supposed identity of *Sanguinolites* and *Allorisma* the late Dr Stoliczka says, "we can say again that unless King's statement and apparently correctly executed figures are disproved, the identity of the two genera must be set aside as inadmissible."* By the same author *Sanguinolites* is placed in the Solemyidæ, but it remains to be seen if any hinge teeth are present.

Allorisma, as originally defined in 1844,† unfortunately contained species of both the last-mentioned genera, but in 1850‡ Professor King properly restricted it, and in this form it becomes, I believe, one of the best defined in the British Carboniferous rocks.

Like *Sanguinolites* the shells of this genus are traversely elongated, equivalve, and edentulous, but with an external ligament. Furthermore the beaks are very anterior, almost terminal, and the pallial line is sinuated. Externally the surface of the valves is granulated. By some writers it is considered identical with the secondary genus *Myacites*, but as pointed out by Messrs Meek and Hayden,§ the edentulous nature of the hinge in *Allorisma* necessitates their separation. Finally, it is not improbable that *Allorisma*, *Sanguinolites*, and *Edmondia*, hitherto all placed in the Anatinidæ, are members of distinct families.

One or two other unimportant genera are said to occur in Scotch Carboniferous rocks, but they do not require any special notice.

The foregoing sketch has been drawn up, not as an exhaustive epitome of the Carboniferous Bivalves, but rather as an indication of some of the difficulties which will have to be met and unravelled before a Monograph of this important class can be written.

The GASTEROPODA, or Univalve shells, like the preceding Class of Bivalves, are sadly in want of revision. The remarks made on the latter are equally applicable here, and may be as justly carried over to the Cephalopoda.

The chief works at present available for the study of the

* Pal. Indica, p. 270.
† Annals Nat. Hist., 1844, xv., p. 315.
‡ Mon. Perm. Foss., p. 196.
§ Pal. Up. Missouri, p. 37.

British Carboniferous Univalves are the writings of M'Coy already mentioned, Phillips' work on the Carboniferous Limestone Fauna of Yorkshire, and Prof. L. de Koninck's *Description des Animaux Fossiles, &c.** In this work full descriptions and good figures may be found of a large number of the Univalve shells common to the Carboniferous rocks of Great Britain and Belgium. Quite recently a magnificent book has appeared from the pen of the same author on the Gasteropoda of the Belgian Carboniferous Limestone. This important addition is comprised in two folio volumes, text and plates. It is entitled *Faune du Calcaire Carbonifère de la Belgique, 4me partie, Gastéropodes*, and forms a portion of the sixth volume of the *Annales du Musée Royal d'Histoire Naturelle de Belgique*. Prof. de Koninck has thoroughly revised the genera to which our Carboniferous Univalves should be referred. In so doing he has conferred an inestimable benefit on practical workers in Carboniferous Palæontology, but has, at the same time, greatly complicated the subject by the description of what appears to us an inordinate number of species. The genera met with in the Carboniferous deposits of Scotland amount to about twenty, and are represented by a large number of species. They are almost wholly confined to the Upper and Lower Limestone Groups, sparingly in the Millstone Grit, just represented in the Coal Measures, but largely so in some areas of the Calciferous Sandstone series, particularly that of Fife.

As a group the Gasteropoda are not numerously represented in any of the beds,† but they are plentiful in some districts; for instance, Mr Young informs us that around Campsie alone twelve genera and forty species may be met with.‡

With the exception of two all the genera belong to the order Prosobranchiata. The two exceptions are *Bellerophon* and *Porcellia*, which are usually regarded as Heteropods. The Pulmonata, or those Univalves breathing air, are, so far as

* 4to, Liége, 1842-44, and Suppl. ed. 1851.

† Armstrong and Young, Catalogue, p. 33.

‡ "On the Gasteropod Mollusca of the Carboniferous Limestone of the W. of Scotland" (Proc. Nat. Hist. Soc., Glasgow, 1868, i., p. 70).

we know, unrepresented, although their presence in the Coal Measures of North America has been shown by Dr Dawson and other writers. I see no reason why Pulmonate Molluscs should not have lived during the deposition of the British Coal Measures, and, like many other things, their presence probably only requires looking for. Some authors, notably Messrs Van Beneden and Coemans,* have endeavoured to prove that our little Annelide *Spirorbis* (*Microconchus*) *pusillus* (Martin) appertains to this group, but the balance of facts appears to prove the contrary;† at any rate, stronger evidence than that offered by these distinguished Palæontologists is required before the Annelidian affinities of this little form can be shaken. We have no definite evidence that the Siphonostomate Univalves existed in the Carboniferous seas of Scotland, the fauna apparently appertaining to the Holostomata, or those with an entire mouth.

The Family Naticidæ is represented by two genera, *Naticopsis* (M'Coy), and one lately established by the writer, *Platyostomella,*‡ for the reception of a peculiar little shell found by Mr James Bennie in the Calciferous Sandstone Series of E. Scotland. On the other hand, Messrs Meek and Hayden believe § some forms of *Naticopsis* really belong to the Neritidæ; they certainly have much the appearance of a *Nerita,* but so far as I am aware, no direct evidence is yet forthcoming. Again, Dr Stoliczka‖ regarded some species of *Naticopsis* as possibly referable to Lamarck's *Ampullina.* The Carboniferous members of the Naticidæ are certainly on anything but a sound basis, for the very existence of *Naticopsis* itself is not directly proven. We have Professor M'Coy at one time describing it without an umbilicus,¶ at another with.** The balance of evidence appears to be in favour of the absence of this feature,†† and taking this into

* Bull. l'Acad. R. Bruxelles, 1867, 2me ser., xxiii.

† Etheridge, "Carboniferous Tubicolar Annelida" (Geol. Mag., 1880, vii., p. 215).

‡ Proc. R. Phys. Soc., Edinb., 1880, p. 163.

§ Pal. Up. Missouri, p. 108. ‖ Cret. Gasterop. of India, p. 295.

¶ Synop. Carb. Lime. Foss., Ireland, 1844, p. 33.

** Brit. Pal. Foss., 1852, p. 301.

†† Illinois Geol. Survey Rept., ii., p. 364.

account, together with the structure of the operculum, it is more than probable that the genus is distinct from its ally, *Natica*. On the whole, I think with Messrs Meek and Worthen, "it will be found to be the type of an extinct family, Naticopsidæ, near the Naticidæ."* A very useful subdivision of *Naticopsis* has been introduced by the same enthusiastic Palæontologists, under the name of *Trachydomia*,† to include such shells as *Buccinum breve* (Sby.), in which the shell is ornamented with small nodes. So far as I am aware, this species has not been met with in Scotch Carboniferous rocks. A new species has lately been described by Messrs Armstrong and Young (*N. Robroystonensis*), with prominent semiarcuate costulæ, but this character appears hardly sufficient to bring it within *Trachydomia*. A re-distribution of the shells now referred to *Naticopsis* is requisite before a satisfactory arrangement can be arrived at. This has to a certain extent been effected by Professor de Koninck, in his recently published fine work, by the introduction of two additional genera for species formerly placed in *Naticopsis*. In the first of these, *Natiria*,‡ is placed a handsome shell, known as *Natica lirata* (Phillips), easily distinguished by the longitudinal lamellæ of the surface, from the other Carboniferous so-called Naticas, that the wonder is it has remained so long unrelegated. The species is met with sparingly in Scotland, for instance, at Arden, near Thornliebank.

The second genus *Tychonia*§ is proposed by de Koninck to receive another aberrant Carboniferous *Naticopsis*, the *N. Omaliana* (De Kon.), again a Scotch species. There is no trace of a callosity upon the return of the spire, as in other *Naticopsis*.

Omitting the two foregoing species the number now appertaining to *Naticopsis* found in Scotland is six, or adding Mr J. Young's last determination of *N. tabulata*,‖ seven in all.

We now approach three shells closely allied to one another,

* Illinois Geol. Report, ii., p. 365. † *Ibid.*, p. 364.

‡ Faune du Calc. Carbonif., Gastéropodes, p. 5. § *Ibid.*, p. 8.

‖ "Notes on the genera of Gasteropod Mollusca from the Carboniferous Limestone Series of the Central and West of Scotland" (Trans. Geol. Soc., Glasgow, 1881, iv., pt. 1, pp. 85-93—see p. 87).

Loxonema (Phillips), *Polyphemopsis* (Portlock), and *Macrocheilus* (Phillips). By some authors these are placed in the Pyramidellidæ, by others in the Turbinidæ,* and again in the Eulimidæ.† Be this as it may, they form a very natural group in Palæozoic rocks, with gradations one between the other, uniting them together.

Loxonema was proposed by the late Professor Phillips for turriculated shells, with a sigmoidal edge to the outer lip, and surface ornamented with longitudinal ridges or threads, but no spiral band.‡ Nine species, met with in Scotch Carboniferous rocks, have been referred to this genus, all, with one exception, being found elsewhere. By many writers *Loxonema* is considered synonymous with *Chemnitzia* (D'Orbigny), but, as Professor M'Coy has observed,§ its species have a deeply sinuated lip and plain apex, which at once separate them from those of the latter. On this subject Mr Meek has made some good and terse remarks. He points out‖ that, as originally proposed by D'Orbigny in 1839, *Chemnitzia* is equivalent to *Turbonilla* (Risso, 1835). The second description by D'Orbigny, in 1850, is much posterior in date to that of *Loxonema* by Phillips, even supposing them to be identical, but Meek inclines to the view that the Palæozoic shells for which *Loxonema* was proposed are distinct from those of later date, and described by D'Orbigny.

At least two of the species met with in the Carboniferous rocks of Scotland, and placed hitherto in *Loxonema*, are spirally striated (*L. polygyra*, M'Coy, and *L. sulcatula*, M'Coy). This is diametrically opposed to the original definition by Phillips, and requires amendment. A genus has been proposed by Meek and Worthen,¶ *Orthonema*, in which the outer lip is straight, and the volutions ornamented with revolving carinæ, but no band or slit as in *Murchisonia*. I am not sufficiently acquainted with the form of the aperture in the above species to be able to form an opinion as to their

* King, Mon. Perm. Foss., p. 209, etc.

† Stoliczka, Cret. Gasterop. of India, p. 290.

‡ Pal. Foss. Devon., etc., p. 98.

§ Brit. Pal. Foss., fas. 3, p. 302.

‖ United States Geol. Survey, Territories, ix., p. 339.

¶ Illinois Geol. Report, ii., p. 380.

relation to *Orthonema*, but that they are not true *Loxonemæ*, I think we may take for granted.

A third species, peculiar to Scotland, *L. clathratula* (Y. and A.), is ornamented with spiral ridges, intersected by longitudinal costæ, but the details of the aperture are not sufficiently known to determine the section to which it belongs. Professor de Koninck has recently divided the Carboniferous *Loxonemæ* into two sections—the *lævigata*, or smooth, and the *costata*, or ridged.*

Again, another genus, although Devonian and not British so far as known, may be referred to here as presenting a further modification of the *Loxonema* type. I refer to *Michelia* of F. A. Roemer,† in which the shell is elongately conical, the body-whorl very much shorter than in a true *Loxonema*, with sharply-turned lines of growth, and a very much bent outer lip.

As intermediate between *Loxonema*, and the following genus *Macrocheilus*, we may consider *Polyphemopsis* (Portlock). ‡ The latter author included under this name elongated, mitra-like, non-umbilicated shells, with an elongated mouth, smooth polished surface, sharp spire, and no wave in the outer lip. One species is met with in the Carboniferous rocks of Scotland, *P. fusiformis* (Sby.),§ but is usually much stunted when compared with the individuals found in England. It is quite possible that the *Eulima Phillipsana* (De Koninck)‖ is referable here, when the number will be increased to two, although the mouth in this shell approaches more to that of typical *Loxonemæ*. The present genus may be distinguished from *Loxonema*, by having a truncated base to the columella, and the smooth surface; from *Macrocheilus* in wanting the callosity and fold, or revolving ridge of the columella seen in that type.¶

* Gastéropodes, *op. cit.*, pp. 41 and 51. † Palæontographica, iii., p. 73.

‡ Geol. Report, Londonderry, 1843, p. 415.

§ Trans. Geol. Soc., 2d series, v., Expl., pl. 39, f. 26.

‖ Anim. Foss. Terr. Carb. Belgique, p. 471. I find that Professor de Koninck has, in his recent work, "Faune du Calcaire Carbonif.," pt. 3, p. 63, published after the above remarks were written, definitely placed this species in *Polyphemopsis*.

¶ Meek and Worthen, Illinois Geol. Report, ii., p. 373.

The third genus of this family, *Macrocheilus,* was originally described* by the late Professor Phillips, for a series of thick, smooth, subglobose or oval shells with convex whorls, and an oval aperture, the columella flattened, imperforate, and with an obtuse revolving fold. Six species are known from the Carboniferous series of North Britain. One or two of these appear to vary to that extent that it is difficult to determine where the one begins and the other ends. One very well-marked character appears to exist throughout the genus, the invariably sharp apex of the spire, whether of the elongated or depressed form of the genus.† In a recently described species, *M. semistriatus* (A. and Y.), the body-whorl is smooth, and the upper ones striate, not a usual feature in this genus.

If we strictly adhere to precedence in synonomy, the name *Macrocheilus* (Phillips, 1841) appears to be subsequent in date to that of *Macrocheilus* (Hope, 1838), proposed as a genus of Coleoptera, and is, therefore, ineligible. Such is Professor de Koninck's view,‡ but I think in this case, that "use and wont" has so long retained the name, that it might be allowed to stand. In place of *Macrocheilus* (Phill.), M. E. Bayle has proposed that of *Duncania,*§ a very inappropriate name, but finding this pre-occupied for a genus of corals, changed it to *Macrochilina,*|| and in this sense it is used by Professor de Koninck.

Since the publication of the "Catalogue of W. Scottish Fossils," Messrs Armstrong and Young,¶ and again Mr J. Young,** have pointed out the existence in the Robroyston deposit, and also in the L. Limestone shales, of two shells provisionally identified with *Elenchus antiquus* (M'Coy), and *E. subulatus* (M'Coy). They are chiefly distinguished from *Macrocheilus* by the presence of a tooth on the pillar lip, in-

* Pal. Foss. Devon., p. 103.

† Meek and Worthen, Illinois Geol. Report, ii., p. 368.

‡ Gastéropodes, *Op. cit.*, p. 28.

§ Jour. de Conchyliologie, 1879, xxix., p. 35.

|| *Ibid.*, xx., p. 241.

¶ Trans. Geol. Soc., Glasgow, iv., p. 278.

** Trans. Geol. Soc., Edinb., 1881, iv., pt. 1, p. 90.

stead of a fold. Under the name of *Strobæus** De Koninck has proposed a new genus for these shells, on the ground that *Elenchus* (M'Coy) is not equivalent to *Elenchus* (Humphrey), the originator of the latter name.

A number of small shells occurring in our Carboniferous rocks have from time to time been referred to *Turbo* and *Trochus*. It has been manifest for many years to Palæontologists in general, that the shells in question, such as *Turbo biserialis* (Phillips), *Trochus biserratus* (Phill.), *T. coniformis* (De Kon.), and *T. lepidus* (De Kon.), have no direct relation with the genera named. The absence of good material has prevented some, whilst a determination not to interfere with accepted names has deterred others from dealing with these troublesome shells. At last, however, Professor de Koninck has grappled the difficult subject in his recent work, and proposed several new genera for their reception.

I have for some time been of opinion that *Trochus biserratus* should be placed in Meek and Worthen's genus *Microdoma*.† The whorls are ornamented with close spiral line, there is no true band, and the lip does not appear to be sinuate. It is much satisfaction to find that De Koninck has placed it in this genus.‡

The *Trochus coniformis* (De Kon.), both a Belgian and Scotch shell, is referred to one of the new genera, under the name of *Flemingia*,§ allied to *Trochus*. Another species, *Trochus lepidus* (De Kon.), now becomes *Turbonellina*,|| a genus again resembling the living *Trochus*, but with a very large umbilicus. Lastly, for *Turbo biserialis* and two other species, the name *Turbonitella*¶ is proposed, a small turbinate univalve, either smooth or tuberculated, and with a depressed callosity on the inner lip. I had already expressed my belief that a distinct genus was required for the reception of this shell.** To complete the genera placed by De Koninck in the Turbinidæ, must be mentioned *Aclisina*.†† In this it is proposed to place, amongst others, a small elongated spiral with

* Gastéropodes, p. 25.

† Proc. Acad. Nat. Sciences, Philadelphia, 1866.

‡ Gastéropodes, p. 104.

§ *Ibid.*, p. 97.

|| *Ibid.*, p. 76.

¶ *Ibid.*, p. 72.

** Annals Nat. Hist., 1880, v., p. 485.

†† *Loc. cit.*, p. 86.

an oval aperture, and long considered as a *Murchisonia* (*M. striatula*), but wanting the band and sinus of that genus.

Under the designation of *Euomphalidæ*, Professor de Koninck has proposed to embrace as a family a most important group of Palæozoic shells, including the sections *Straparollus*, *Euomphalus*, and the like.* The principal characters assigned to the family are, a more or less large and open umbilicus, external margin of the mouth furnished with one, two, or three sinuses, of which the surface of the body whorl retains only the slightest traces, their existence being shown by keels, or imbricating lamellæ of growth,—camerated nature of the shell, and the presence of a strong operculum. The proper generic or sectional subdivision of the shells, usually known hitherto under the name of *Euomphalus*, has caused endless trouble to Palæontologists. No less than eleven species are said to be found in the Carboniferous rocks of Scotland; indeed, next to *Pleurotomaria*, this section contains the largest number of species of any Univalve met with in the Carboniferous System. In a paper † published not long ago I endeavoured, to a certain extent, to unravel this confusion, and since then Professor de Koninck, with better material at his disposal, has accomplished the matter. Professor de Koninck regards the various divisions of *Euomphalus* and *Straparollus* as of generic value, whereas I looked upon them merely as sectional divisions of the larger genus, but after carefully perusing his observations, I believe his arrangement to be the better of the two.

The genus proper is *Straparollus* (De Montfort), containing the conical forms with a large umbilicus, and an oval or round mouth. The Scotch species are *S. Dionysii* (De Montf.) and *S. pileopsideus* (Phill.); the first section is *Euomphalus*, in which I comprised all those species having a depressed, discoid, pentagonal form. On the other hand, De Koninck admits here only those of a similar shape but with a single spiral keel, either in the middle or upper part of the

* Gastéropodes, p. 81.

† "Notes on the Gasteropoda contained in the Gilbertson Collection, British Museum, etc." (Annals Nat. Hist., 1880, v., pp. 473-485; vi., pp. 289-301).

whorl. As thus restricted, the following Scotch species are here comprised—*Euomphalus pentangulatus* (Sby.), *E. acutus* (Sby.), and, I presume, *E. marginatus* (M'Coy).

The next division instituted by Professor de Koninck is *Phymatifer*,* in which the form is discoid, no spiral keel, but the upper surface of the whorls and sometimes the lower ornamented with rounded tubercles. This section would comprise *Phymatifer* (*Euomph.*) *pugilis* (Phill.), and perhaps *P.* (*Euomph.*) *tuberculatus* (Fleming). For the next group the genus *Schizostoma* (Bronn)† has been adopted, and comprises those shells similar in form and general character to *Euomphalus* proper, but the body whorl bi-carinated, one keel placed on the upper, the other on the lower surface; the Scotch type of this group will be *Schizostoma* (*Euomph.*) *calyx* (Phill.), and it will also include *S.* (*Euomph.*) *carbonarius* (M'Coy).

The value of these sections entirely depends upon the stability of the characters of the species placed in them. The group *Phymatifer* will probably form a good section, but the separation of *Euomphalus* and *Schizostoma* is, unless the specimens are very well preserved, difficult to accomplish, especially in so far as the uni- and bi-carinated nature of the whorls is concerned. Lastly, I believe, we have a further section of this group of shells in Meek's *Omphalotrochus*, a massive tabular shell in which will probably be included the large *Euomphalus tabulatus*.

The genus *Raphistoma* (Hall) has hitherto been supposed to be entirely Silurian, but Professor de Koninck now employs it for some Carboniferous Univalves, amongst which may be mentioned *Euomphalus radians*, occurring both in this country and Belgium. The group *Euomphalus* is remarkable for the camerated nature of the shell, a feature often beautifully shown in polished sections of *E. pentangulatus*. One of the least common species met with in the Carboniferous rocks of Scotland is probably the *Euomphalus crotalostomus* (M'Coy) found by Mr J. Linn in the Bathgate limestone.‡ This also appertains, I am inclined to believe,

* Gastéropodes, p. 149. † *Ibid.*, p. 152.

‡ "On some of the less common Bathgate Fossils" (Trans. Geol. Soc., Edinb., 1873, ii., pt. 2, p. 192).

to the section *Omphalotrochus.** Similarly some species occur in great abundance at various localities, for instance Mr Young states that great quantities of *Euomphalus carbonarius* are often found together.†

We have hitherto dealt with Univalves possessing an entire outer lip to the mouth, but we have now to consider a very interesting group composed of *Pleurotomaria* and *Murchisonia,* in which the outer lip is sinuated, and the whorls provided with a revolving band. We may also regard here the genus *Platyschisma* of M'Coy. These shells have usually been referred to the *Haliotidæ,* but it seems desirable to range them in a separate and distinct family, the *Pleurotomariidæ,* thus following several well-known authors.‡

As it at present stands, *Pleurotomaria* (Defrance) is a most unwieldy genus, and amongst its species presents great modification of structure within certain limits. It contains both umbilicated and imperforate shells, and many degrees of variety are noticeable in the position and strength of the spiral band, length of the sinus, and height of the spire. Generic division is very desirable, and will have to be effected on a combination of these characters. Unfortunately we are here presented with an obstacle, only too common in such cases—the extreme variability and inconstancy of the latter throughout the range of species contained in the genus.

One good subdivision, not usually recognised, has, I believe, been made by d'Orbigny. Under the name of *Polytremaria,*§ he has separated those forms possessing a constricted and partly obliterated band, represented by oval foramina round the whorls, some of which, at least, always remain open. A Carboniferous species of this section is met with in Belgium (*P. catenata,* De Kon.), but so far as I know is not found in Britain.

Two of our Carboniferous shells, the *Helix ? striatus* (Sby.) and *H. ? cirriformis* (Sby.), and usually referred to *Pleuro-*

* And *may* be identical with *O. tabulatus* (Phill., sp.).

† "On the Gasteropod Mollusca of the Carboniferous Limestone of the West of Scotland" (Proc. Nat. Hist. Soc., Glasgow, 1863, i., p. 70).

‡ See King, Perm. Foss., England, p. 213.

§ Prod. de Pal., i., p. 122.

tomaria, have been raised to generic rank as *Ptychomphalus* by the late Professor Agassiz.* They are trochiform shells, with a narrow band and short slit; they are said to possess an almost smooth surface, and a thick callosity covering the umbilical region. Now, I have examined the type specimens of both these species, and I think they can hardly be denominated smooth shells, whilst the thick callosity is certainly not well exhibited. The genus or section will probably, however, be useful for the reception of the Palæozoic imperforate *Pleurotomariæ* in combination with some restriction as to form. According to Dr Stoliczka,† *Ptychomphalus* is largely represented in the older deposits, but although the above shells are found in the English Carboniferous limestone I am not aware of their occurrence in Scotland. Judging from the description of *Cryptœnia*,‡ by Deslonchamps, I quite agree with Stoliczka in believing it to be identical with Agassiz' *Ptychomphalus*. The only other Palæozoic subdivision of *Pleurotomaria* known to me is the genus *Trochotremaria* (De Ryckholt),§ and I quite fail to perceive any difference between it and the before-mentioned *Polytremaria*. The application of these subdivisions to our Palæozoic *Pleurotomariæ*, and any further restriction of the genus can only be effected by a thorough examination and revision of the species, a work of much time and trouble. A very interesting species of *Pleurotomaria* has been described from the Lower Limestone series of Craigenglen, near Campsie, by Mr J. Armstrong.‖ It is, I believe, exceptionally a Scotch shell, and may perhaps belong to the section *Ptychomphalus* (Ag.) = *Cryptœnia* (Eg. Deslonchamps).

The genus *Murchisonia* was established by Messrs d'Archiac and De Verneuil ¶ for Palæozoic Shells, many of which had been previously referred to *Buccinum*, *Turritella*, etc. The

* German Edition of Sowerby's Min. Con.

† Cretaceous Gasterop. of India, p. 382.

‡ Bull. Soc. Linn. de Normandie, 1865, ii., p. 424.

§ Jour. de Conchol., 1860, viii., p. 186.

‖ Description of two new species of shells from the Carboniferous Limestone of Clydesdale (Trans. Glasgow Geol. Soc., ii., pt. 1, p. 74).

¶ Bull Soc. Géol. de France, 1841, xii., p. 159.

species composing it, of which six are known from the Carboniferous rocks of Scotland, are turriculated shells. The aperture is oblique, oblong, and produced below, more or less, into the semblance of a very short or truncated canal. A distinct sinus occurs in the outer lip, and a band, single or double, is traceable on all the whorls. *Murchisonia,* if we omit the tendency to an effuse mouth, stands much in the same relation to *Pleurotomaria* that *Loxonema* does to *Macrocheilus.* Professor de Koninck * divided the genus into two sections according to the ornamentation—the *M. coronatæ,* or nodular species, and the *M. sulcatæ,* or striated and grooved forms. The latter section is by far the most numerous, and comprises the whole of the Scotch species. On the other hand the late Mr J. W. Salter selected the form of the whorls with the view of subdividing *Murchisonia.* He restricted the latter name, unfortunately, to short turbinate shells, and not to elongated and turriculated forms selected by D'Archiac and De Verneuil as the types of their genus. Many of the elongated forms have rounded whorls, and had Salter simply divided the Murchisoniæ with a lengthened spire, into those with rounded whorls, and those with angular whorls, using his *Hormotoma* for one of these, it probably would stand the test of investigation. There is, then, no reason why the short turbinate shells, otherwise agreeing with the original diagnosis of *Murchisonia,* should not furnish a third section.

To complete this group of shells we must not neglect to notice *Platyschisma* (M'Coy).† In this genus are included obtusely conical, ventricose, umbilicated smooth shells, with a shallow sinus in the outer lip, but no defined band. They resemble depressed smooth *Pleurotomariæ,* devoid of a band, and the sinus reduced to a mere inflection of the outer lip. So far as we know, only one species is met in Scotch Carboniferous deposits, the *Platyschisma ovoidea* (Phillips).

The curious Family of the Capulidæ is represented in our Carboniferous rocks by several species referable to the existing genus *Capulus* (Montfort). Several names have been

* Anim. Foss. Terr. Carb. Belgique, p. 409.

† Synop. Carb. Lime. Foss., Ireland, 1844, p. 38.

proposed—*Pileopsis* by Lamarck, *Platyceras* by Conrad, and *Acroculia* by Phillips for these shells, but as they do not appear to possess any essential difference from De Montfort's genus, these become obsolete.* Should it become necessary to employ a separate name for the Palæozoic shells, *Platyceras* should be selected. Several sections of the genus have been proposed, but as none of the species referable to these are met with in Scotland, they will not be here referred to. The species of the Scotch Carboniferous limestone number four or five.

The peculiar aberrant order of the Solenoconchiæ or Prosocephala is represented in our Carboniferous rocks by one genus *Dentalium*. The species met with in Scotland are computed by Mr J. Young at five,† *Dentalium ingens* (De Koninck), *D. priscum* (Goldf.), *D. inornatum* (M'Coy), *D. Scoticum* (Young), and *D. Dalriense* (Young). To these must be added a sixth, *Dentalium ornatum* (De Koninck), found by Mr J. Henderson.‡ According to Mr Young's researches, the genus is not met with in any of the purer beds of limestone, but from the accompanying shales, which he concludes to indicate their abode in seas of less depth than those in which the limestones were deposited. In the present unsatisfactory state of the genera comprising the Dentaliidæ, it is impossible to indicate any generic distribution of the species beyond the broad one of *Dentalium*. According to Dr Stoliczka, this term should be restricted to certain species with longitudinal ribs,§ a section which did not flourish largely during Carboniferous times.

We next pass to the Order Cyclobranchiata, of which the Carboniferous representatives are *Chiton* and *Chitonellus*. The first notice of this interesting group is contained in a paper by Messrs Young and Kirkby,‖ in which are described

* See a summary of this subject, Annals Nat. Hist., 1880, vi., p. 296.

† "On the species of *Dentalium* found in the Carboniferous Strata of the W. of Scotland" (Proc. Nat. Hist. Soc., Glasgow, 1880, iv., pt. 1, p. 69).

‡ Etheridge, Geol. Mag., 1878, v., p. 117.

§ Cret. Gasterop. of India, p. 437.

‖ "Provisional notice of a new *Chiton*, and a new species of *Chitonellus*, from the Carboniferous Rocks of the W. of Scotland" (Trans. Geol. Soc., Glasgow, 1865, ii., pt. 1 p. 13).

plates of *Chiton humilis* (Kirkby) from the Upper Limestone Series, and *Chitonellus Youngianus* from the Main Limestone beds. Other additions have been made to the list by Mr J. Thomson,* and again by the before-mentioned authors.† In all, three species of *Chiton* and two of *Chitonellus* have been recognised, but of late a highly interesting siliceous *Chiton*-bearing limestone has been investigated by Mr James Bennie at Dalry.‡ This deposit has yielded to Mr Bennie, and Mr J. Smith of Kilwinning, nearly a dozen species of *Chiton* and *Chitonellus*, irrespective of those previously discovered. The Chitons chiefly belong to the elongated form of the genus which flourished during the Carboniferous period, and probably has relations with the Silurian species for which Salter proposed the name *Helminthochiton*. One or two forms, on the contrary, essentially differ from this. The Chitonelli include some very peculiar, and one or two unique forms, others approach the recent species more than they do the intermediate fossil shells. Mr Bennie's discoveries will be described in the forthcoming part of the *Proceedings* of the Natural History Society of Glasgow.

The concluding order of the Gasteropoda we have to notice is the Heteropoda or Nucleobranchiata. As before stated only two genera need consideration here—*Bellerophon* and *Porcellia.*

Bellerophon is represented in Scotch Carboniferous rocks by no less than twelve species and two varieties, presenting a wide range in form. One of the most characteristic, and, notwithstanding its common occurrence in certain places, least known species is the *B. cornuarietis.* It forms the British type of Hall's section *Bucania,* in which all the whorls are visible and gradually increase in size. The shell is convolute, and the aperture abruptly expanded. In almost every case *B. cornuarietis* is met with as casts in limestone; in fact, I do not personally recollect ever seeing one in any other condition. One of the most typical Scotch species of *Bellerophon* is *B. Urei,* long ago figured by David Ure.

* Trans. Geol. Soc., Glasgow, 1865, ii., pt. 1, p. 15.

† Geol. Mag., 1867, iv., p. 340 ("Notes on some remains of *Chiton* and *Chitonellus* from the Carboniferous Strata of Yorkshire and the W. of Scotland").

‡ Quart. Jour. Geol. Soc., 1847, iii., p. 48.

Amongst other species this was some years ago selected by Professor M'Coy to represent his section *Euphemus*,* a name proposed for globose Bellerophons, with a spirally striated surface, and, as it was thought, no dorsal hand. Although the latter point is a misconception, as Professor M'Coy himself pointed out afterwards,† it may be with advantage employed, in a sectional sense, for such forms as *B. Urei.* A variety of names have been proposed for various sections of the genus *Bellerophon*, in addition to the two just mentioned, but it is questionable if any of them can be applied to the British Carboniferous forms. Such sub-genera are *Tropidodiscus* (Meek), *Salpingostoma* (F. Roemer), and *Tremanotus* (Hall).

Much difference of opinion exists in regard to the systematic position of the Bellerophons. By most authors they are placed in the Family Atlantidæ of the Order Heteropoda, but Professor M'Coy established for them a distinct family under the name of Bellerophontidæ.‡ He regarded them as Monothalamous Tetrabranchiate Cephalopods, here following many of the older writers, but although we cannot agree with him in this step, we believe the establishment of the family one in the right direction. A very interesting paper, "Note on the Affinities of the Bellerophontidæ,"§ has been written by the late Mr Meek. In it he calls attention to a much overlooked suggestion of Professor de Koninck made in 1844,‖ who placed *Bellerophon* near *Emarginula* (in the Scutibranchiate order of the Prosobranchiata), "viewing them as *Emarginulæ* with a greatly extended and strongly involuted apex." More recently Dr Waagen has entered on this subject, and proposed still further sub-divisions of the genus *Bellerophon*, under the names of *Patellostium*, *Mogulia*, *Warthia*, and *Stachella*, all with reference to the form of the mouth and striation of the shell. Their application to British species remains to be worked out.¶

Mr Meek believed this reference on the part of the distin-

* Synop. Carb. Lime. Foss., 1844, p. 25. † Brit. Pal. Foss., p. 380.
‡ *Ibid.*, p. 307. § Proc. Chicago Acad. Science, 1866, i. (separate copy).
‖ Anim. Foss. Terr. Carb. Belgique, p. 337.
¶ Pal. Indica, Ser. xiii., Salt Range Fossils, pt. 2, 1880, pp. 131, 156, 158, and 171.

guished Belgian Palæontologist to be greatly strengthened by the structure of the genus *Tremanotus* (Hall). In this shell, which otherwise has the form of *Bucania*, there is along the middle of the dorsal side "a row of isolated oval-siphonal openings." Closely allied, if not identical with this, is the genus *Salpingostoma* (F. Roemer), in which there is one elongated dorsal aperture on the body whorl, but distant from the outer lip. Mr Meek concluded his interesting remarks thus:—"Now we have no examples, so far as known to the writer, either amongst the Heteropoda or Cephalopoda, living or extinct, of a shell with isolated siphonal openings, while we have many such examples amongst the Prosobranchiate Gasteropoda,—such for instance as the Haliotidæ, Fissurellidæ, and Pleurotomariidæ—the bearing of this feature in the newly-discovered type has on the question respecting the affinities of the Bellerophontidæ, will be readily understood. In other words it indicates for the family a position near the Fissurellidæ and Haliotidæ, and between those groups and the Pleurotomariidæ."*

In these remarks I cordially concur, and following the researches of Messrs De Koninck and Meek, would suggest the transfer of *Bellerophon* and the allied genus *Porcellia* to the systematic position assigned by these writers.

The genus *Porcellia* (Léveillé) has a depressed discoidal form, with the whorls in one plane, with the exception of the nucleus, which is spiral. The umbilicus is large and open, exposing all the whorls. The outer lip is medionally divided by a sinus, represented along the dorsal line by a groove. The genus differs from *Bellerophon* chiefly in its thin shell, depressed form, and highly ornate surface. One species only is met with in the Carboniferous rocks of Scotland, *P. armata* (De Vern.), a characteristic shell of the Russian Carboniferous limestone, whilst, strange to say, the species found in the English Carboniferous limestone, *P. Woodwardi* (Martin, sp.), has not been met with there.

In addition to the shells we have discussed in their

* Meek, *loc. cit.* Dr Waagen also arrives at pretty much the same conclusions (*op. cit.*, p. 129).

regular serial order, a few other doubtful species have been referred to. In an interesting and recently published paper, "On the Genera of Gasteropod Mollusca from the Carboniferous Limestone Series of the Central and Western Coalfields of Scotland,"* Mr J. Young mentions the following:—A species of *Niso* from the Upper Limestone Group of Dalry, the only other reported occurrence of this genus being in the Devonian rocks of Australia.† *Siliquaria* again, an Eocene genus, is said to occur in the Upper Limestone shales of Carluke, in the form of a spiral tubular shell, with an open slit along the outer or dorsal margin.

Before concluding our brief review of the Scotch Carboniferous Gasteropoda, a few words must be said about the occurrence of detached opercula. Comparatively few instances are on record of these organs in a separate state in our Carboniferous rocks or even found *in situ*. My friend, Mr James Bennie, was fortunate enough to discover a number of bodies in the siliceous limestone of Dalry quarry, Ayrshire, which are believed to be none other than the opercula of small Gasteropoda. They have, to a certain extent, the appearance of little otoliths, but as one variety was actually observed in the mouth of a small naticiform shell, and their structure otherwise corresponds to that of other opercula, we have regarded them as such.‡

We are confirmed in our opinion by the recently published figures of Professor de Koninck, who gives a series of several species of *Naticopsis*,§ in every way corresponding to those from Law quarry, but much larger. More than this, De Koninck figures some conical bodies,‖ formerly described by him as a genus of Brachiopoda, under the name of *Hypodema*, and before that as a *Calceola*. These he now believes to be the operculum of *Euomphalus*. They are pyramidal objects, no two of them alike, one face flat, the other convex, with the summit eccentric and recurved. The inner surface is smooth

* Trans. Geol. Soc., Edinb.

† Foss. Pal. Nouv. Galles du Sud., p. 127.

‡ See Etheridge, Annals Nat. Hist., 1881, vii., pp. 25-31, t. 2.

§ Gastéropodes, p. 148, t. 2, figs. 10 and 11, 13 and 14, 23-25.

‖ *Ibid.*, t. 9, f. 74-80.

and divided into unequal portions by a crossbow-shaped groove. It is quite possible these may be the operculum of *Euomphalus,* although the objects described by Mr F. Smythe as those of the Silurian forms of this genus, and which we definitely know to be such by demonstration, are discoid and flat and marked externally with circular raised lines.* On the other hand, I have myself figured a body from the Upper Silurian beds of the Island of Gothland † as the operculum of a *Euomphalus,* conical in outline, and much more nearly allied to those of Professor de Koninck. One other fact remains to be stated; so far as I am aware no object resembling the so-called *Hypodema* has been met with in British Carboniferous rocks, notwithstanding the prevalence of the Euomphalidæ in them.

The PTEROPODA, or Pelagic Mollusca, are represented in the Carboniferous system by only one genus, *Conularia,* and one or two species. The shell of *Conularia* is straight, four-sided, tapering towards the distal end, and externally ornamented with transverse granulated ridges. In the majority of instances the shell is of extreme tenuity, and is usually said to be nonseptate, but two species have been described in which septa or a siphuncle were visible. These are *Conularia teres* (Sby.)‡ and *C. Trentonensis* (Hall).§ The first, it may be said with tolerable certainty, is not a *Conularia* at all, as was surmised by Sowerby himself. The structure of the second has left the position of *Conularia* in the Pteropoda open to doubt. So far as I am aware, however, no direct confirmation of this Cephalopod-like structure in *Conularia* has hitherto appeared. || The *C. teres* is a Scotch fossil, and should be found in the Fleming Collection, from which it was borrowed by the Sowerbys for description. It would be extremely interesting to show its true generic relationship; it will probably be with either *Orthoceras* or *Cyrtoceras.*

* Proc. Cotteswold Nat. Field Club.

† Annals Nat. Hist., 1881, vii., t. 2, f. 9.

‡ Min. Con., iii., 1820, p. 108, t. 260, f. 1 and 2.

§ Pal. N. York, i., p. 222, t. 59, f. 4, *a, f.*

|| Mrs Gray has lately found a Silurian *Conularia* at Girvan, in which both siphuncle and septum are preserved.—August 1882.

The Carboniferous species of *Conularia* occurring in Britain is *C. quadrisulcata*, and is very seldom found in a perfect state. The proximal or larger end is usually crushed inwards, or broken short off at the margin. Mr James Bennie, however, was successful enough to find an example with the rhombic larger end partially closed by the bent down and reflected margins, leaving a quadrangular opening in the centre. The four corners of this opening form re-entering angles, which join the four angles formed by the union of the conical sides of the shell.* Whether this structure closed the orifice of *Conularia* or not, it is difficult to say. Did it act the part of an operculum? An allied form, *Theca operculata* (Salter),† from the L. Tremadoc beds, possesses such an organ, and it is quite possible the inturned edges may perhaps have at the least given support to some kind of lid. To those possessing a large series of *Conulariæ*, the study of the genus would well repay them, for it is one of the forms of our old rocks of which we know comparatively little. The shape of the shell somewhat resembles that of some living Pteropods, although in the matter of size it is simply a giant compared with the latter.

The CEPHALOPODA, or highest class of the Mollusca, is represented in the Carboniferous Limestone Series by the smallest number of genera of any except the Pteropoda, just referred to. The genera number six, and all appertain to the Tetrabranchiate division of the class. The greatest number of species occur in the genera *Orthoceras* and *Goniatites*, but it is very probable, as too often happens amongst Palæozoic shells, that a number of these will disappear from our records on a close and vigorous examination. According to Messrs Armstrong and Young, the greatest number of species are found in the upper group of limestones, chiefly in the form of casts. The best preserved specimens come from the limestone shales, and frequently

* See Etheridge, Structure of *Conularia* (Geol. Mag., 1873, x., p. 295).

† Mem. Geol. Survey, iii., p. 351, t. 10, f. 22-24.

have the outer shell well preserved, whilst *Orthoceratites* even retain traces of chevron-shaped bands of colour.*

The special bibliography of the Scotch Carboniferous Cephalopoda is of the most limited description. The first to describe members of this Class after the Rev. David Ure was Professor Fleming, who furnished descriptions of no less than ten species.†

As specially relating to Carboniferous Cephalopoda, we must not omit to mention the first and second parts of the magnificent work by Professor de Koninck referred to when treating of the Gasteropoda.‡ The same sumptuousness of illustration and fulness of description is carried out, and will allow the future determination of species to be a task of greater ease and pleasure.

The large Family Orthoceratidæ contains the genera *Actinoceras* (Bronn), *Cyrtoceras* (Goldfuss), *Orthoceras* (Breynius), *Aploceras* (D'Orbigny), etc.

The unwieldy genus *Orthoceras* is largely represented in Scotch Carboniferous Limestone beds, no less than twenty-two species having at one time or the other been described or listed. The names of many of these will doubtless prove to be synonyms; some certainly are now known to be so. No shells, except perhaps the Goniatites, are so difficult of correct determination as those of the present genus. Sometimes found as casts, often in fragments, and differing as they do in various parts of their length, it is at times extremely difficult to draw the line where one species commences and the other ends. This difficulty is not lessened by the loose manner in which many of the descriptions have been drawn up.

Professor M'Coy employed several sectional names under *Orthoceras* for the limitation of the species. Two at least of these are equivalent to the genera of other observers, whilst two others may perhaps be employed in the manner sug-

* W. Scot. Fossils, p. 58.

† "Observations on the Orthoceratites of Scotland" (Thomson's Annals Phil., 1815, v., p. 199).

‡ Annales du Musée R. d'Hist. Nat. de Belgique, v.; Faune du Calc. Carbonif. de la Belgique, 1me partie.

gested by their author. For instance, I see no reason why *Loxoceras** should not be employed for those Orthoceratites with an oval section, the septa waved and placed obliquely with respect to the axis of the shell, and an eccentric siphuncle. This section is typified by the *O. Breynii* (Martin, sp.), a species met with in Scotland. Again *Cycloceras*† was intended for conical forms marked with prominent concentric rings, and a dorsal siphuncle. The type of this division is again a Scotch fossil, *Orthoceras annulare* (Fleming). M. A. D'Orbigny established a genus under the name of *Aploceras*‡ for certain Carboniferous Cephalopods, with a horn-shaped shell, and a subcentral siphon. Amongst these he introduced the *Orthoceras dentaloideum* (Phill.),§ which has been found at the South Hill, Campsie.‖ I have examined the figured type specimen of this species, and I find it to be most unquestionably a *Dentalium*, possessing all the characters of the Carboniferous forms of that genus. The late Professor Fleming described two Orthoceratites, *O. undatum* and *O. sulcatum*, which appear to be identical; the former is said to have the annular ridges of the shell waved and smooth, the latter waved and striated, but specimens have come under my observation in which both these characters were combined.

The latest arrangement of the Carboniferous Orthoceratites is that of Professor de Koninck,¶ who gives the following general classification:—

ORTHOCERAS.

Group I.—Siphon cylindroid—	Group II.—Siphon nummuloid—
1st. *Lævia*, surface smooth, or nearly so. a. *Gracilia*. b. *Regularia*.	1st. *Nummularia*, surface smooth, or nearly so.
2d. *Annulata*, surface with wrinkles or concentric rings.	2d. *Moniliformia*, surface striated longitudinally.
3d. *Lineata*, surface with striæ or longitudinal ridges.	

* Synop. Carb. Lime. Foss., 1844, p. 6. † *Ibid.*

‡ Prodrome de Pal., i., p. 112.

§ Geol. Yorkshire, 1836, ii., p. 239, t. 21, f. 12.

‖ W. Scot. Fossils, p. 59.

¶ Faune du Calc. Carbonif. de la Belgique, 1880, pt. 2, p. 50.

From *Orthoceras* we pass to *Actinoceras*, in which the shell resembles the former, but the siphuncle is unusually large, inflated between the chambers, and having a slender central tube. Only one species has at present been described in the British Carboniferous series, the *Actinoceras giganteum* (Sby.), one of the largest of all the Orthoceratidæ. This species is sometimes met with many feet in length, and with a corresponding circumference. This is especially the case with specimens from the Closeburn Limestone, Dumfriesshire, the locality from which Mr James Sowerby's original specimen was derived. Mr Sowerby estimated the size of his specimen when complete at exceeding 8 feet.* Another favourite locality for this gigantic fossil, according to Messrs Armstrong and Young, is Orchard Quarry, where "instructive examples, showing the large-headed siphuncle" are met with.

In the genus *Cyrtoceras* (Goldfuss), we find simply a curved or horn-shaped *Orthoceras* with a small siphuncle, generally subcentral to dorsal. Three species are met with in Scotland, and only about two more are known in the Carboniferous Limestone of England. *Cyrtoceras rugosum* (Fleming, sp.) is perhaps the most characteristic species, and was originally described by Dr Fleming as an *Orthoceras*. Professor M'Coy described the genus under the name of *Campyloceras*, but his name has to give place to that of Dr Goldfuss.

Professor de Koninck gives a rather complicated arrangement of *Cyrtoceras* expressed by the following table: †

Group A.—Cyrtocerata Exogastrica—	Group B.—Cyrtocerata Endogastrica—
Sec. 1. *Lævia*, siphon cylindroid.	Sec. 1. *Ornata*, siphon cylindroid.
,, 2. ,, ,, nummuloid.	,, 2. *Lævia*, ,, nummuloid.
,, 3. *Ornata*, ,, cylindroid.	
,, 4. ,, ,, nummuloid.	

The last genus of this Family to be noticed is *Gomphoceras* (J. de C. Sby.).‡ The Carboniferous species placed here are

* Min. Con., iii., p. 81.

† Faune du Calc. Carbonif. de la Belgique, 1880, pt. 2, p. 17.

‡ Murchison's Sil. System, 1839, p. 621.

usually listed under the name of *Poterioceras* (M'Coy), but both the late S. P. Woodward* and Professor F. J. Pictet† have drawn attention to the identity of the two. The former name has precedence by many years. Three species only are known from the British Carboniferous, all of which are found in Scotland. Only one of these has, so far as my knowledge of the subject goes, been discovered in the East, viz.: *G. ventricosum* (M'Coy).‡ Another species, *G. cordiformis*, attains a very large size, forming a fit companion for the huge *Actinoceras giganteum*, with which it is associated in the limestone at Closeburn. §

The Goniatites were formerly placed in the Family of the Ammonitidæ, but M. Barrande has shown that they differ from the structure usually assigned to this group in several very important particulars.‖ He has therefore separated the genus *Goniatites*, and placed it in a Family by itself, the Goniatitidæ. Fourteen species are said to exist in the Scotch Carboniferous Limestone, and form perhaps the most difficult and complicated group of shells of the whole series; moreover, they are said by Messrs Armstrong and Young to be usually of small size.¶

In bringing this short and imperfect notice of the Scotch Carboniferous Cephalopoda to a close, we must not omit the genus *Nautilus*, of which nine species are known to occur. These are referable to four sections of the genus, *Nautilus* proper, *Discites* (M'Coy), *Temnocheilus* of the same author, and *Trematodiscus* (Meek and Worthen). *Discites* is represented by *N. quadratus* (Fleming), from various localities; *Temnocheilus* by *N. biangulatus* (Sby.) and *N. globatus* (Sby.); *Trematodiscus* by *N. sulcatus* (Sby.), and so on. A very typical, and, I believe, purely Scotch *Discites* has been described by Mr J. Armstrong as *N.* (*Discites*) *nodiferus*,** and is almost confined to the Upper Limestone Group.

* Man. Mollusca, p. 89. † Traité de Pal., 1854, iii., p. 644.

‡ J. Livingstone, "On *Poterioceras ventricosum* from the Carboniferous Series near Gorebridge" (Proc. Roy. Phys. Soc., Edinb., i., p. 470).

§ Min. Con., iii., p. 85.

‖ Bull. Soc. Géol. de France, 1856, xiii., p. 375.

¶ Catalogue, p. 62. ** Trans. Geol. Soc., Glasgow, 1865, ii., pt. 1, p. 74.

De Koninck subdivides the genus *Nautilus* of the Carboniferous Rocks into nine sections or groups, according to the external form, governed by the ornament, and other characters,* viz.:—

1. Globosi.	5. Disciformes.
2. Atlantoidei.	6. Lenticulares.
3. Serpentini.	7. Sulciferi.
4. Tuberculati.	8. Cariniferi.

9. Ornati.

The DISTRIBUTION of the Mollusca from a Geological point of view is a subject of much interest. So important a one, however, cannot be treated properly in the small space at our disposal, a mere passing reference must therefore suffice.

The lowest division of the Carboniferous System in Scotland—the Calciferous Sandstone Series—is regarded, generally speaking, as a deposit of fresh or brackish water origin. Researches carried on of late years have revealed the presence in this series of numerous bands of marine origin, containing a fair preponderance of marine Mollusca. Scattered throughout the Wardie shales we do occasionally meet with a few bivalve shells, probably referable to *Anthracoptera*, or an allied genus, without associated marine fossils, or other surroundings of a marine nature.

Definite horizons with marine fossils in the Calciferous Sandstone of the East of Scotland were first indicated by the late Mr J. W. Salter and other officers of the Geological Survey. Thus, such a stratum was discovered at the Clubbiedean Reservoir containing a well-marked bivalve.† Again in Berwickshire similar beds at Cockburnspath and Burnmouth yielded *Athyris ambigua*, *Modiola*, *Pteronites*, *Edmondia unioniformis*, *Aviculopecten*, and *Anthracomya*.‡ This bed, an impure limestone at Cockburnspath Cove, was investigated by Messrs Gibbs and Salter, and was found to be situated near the very *base* of the Calciferous Series.§

The finest development of the Calciferous Sandstone Group,

* Faune Calc. Carb. Belg., 1871, pt. 1, pp. 90, 91.
† Mem. Geol. Survey, Scotl., No. 32, p. 144.
‡ *Ibid.*, No. 34, 1864, pp. 43 and 57.
§ *Ibid.*, No. 33, 1866, pp. 28 and 73.

however, takes place in Fifeshire, where a magnificent section is exposed along the sea coast. One of the first, if not the first description of these beds and the accompanying Carboniferous limestones was given many years ago by Mr Landale in a "Report on the Geology of the East of Fife Coalfield,"* with a list of organic remains. The next to investigate these beds was the Rev. T. Brown, whose classic paper, "Notes on the Mountain Limestone and Lower Carboniferous Rocks of the Fifeshire Coast from Burntisland to St Andrews,"† is too well known to need comment from me. Mr Brown showed the existence of a copious marine fauna at certain horizons in the lower series. From one of these, the Ardross limestone, he obtained fossils which would by no means do discredit to many limestones of the Lower Carboniferous Limestone Group, but containing distinctive shells, the chief of which is a well-marked *Schizodus.* Several other defined horizons were detected by Mr Brown, for instance, the *Natica* bed at Billowness and Caiplie, and again at Fifeness.

More recently Mr J. W. Kirkby has published the result of researches carried on in the same district for some years,‡ and in doing so has greatly increased the number of marine bands in this series than previously known to us. The lowest is seen at Anstruther-Wester, where one species each of Cephalopoda, Gasteropoda, and Lamellibranchiata is found. The group of marine beds at the top of the Series (Zones, 1-4), between St Monance and Pittenweem, when compared with the Carboniferous Limestone, present a fauna rich in Bivalves and poor in Brachiopods. Much difference in the fauna is not visible till below Zone 5, when one or two species occur so often and abundantly "as to mark these lower measures with special palæontological features." Such are *Myalina modioliformis, Schizodus Salteri, Platyostomella Scotoburdigalensis,* and a greater paucity of Brachiopoda. Mr Kirkby finds that the zones of fossils are not all equally marine, but some more so than others.

* Trans. High. Soc., 1838, v., p. 338.

† Trans. Roy. Soc., Edinb., 1861, xxii., pp. 385-404.

‡ "On the Zones of Marine Fossils in the Calciferous Sandstone Series of Fife" (Quart. Jour. Geol. Soc., 1880, xxxvi., pp. 559-590).

Massing the whole marine beds together we find that they contain—

Brachiopoda,	11 genera,	18 species.
Bivalves,	15 „	33 „
Gasteropoda,	11 „	12 „
Cephalopoda,	2 „	4 „

The investigations carried out by Mr James Bennie and Mr Henderson supplemented by those of other collectors have established the occurrence of several marine bands in the Wardie shales around Edinburgh. Although smaller in development they are not of less importance; one of the beds, that at Woodhall, showing the first appearance of the Pteropoda. Another marine deposit has been investigated by Mr Henderson, viz., some shales overlying the greenstone of Craiglockhart Hill, in which both Brachiopoda and Lamellibranchiata appear. In addition to the two mentioned, three or four others are known to exist around Edinburgh. A full description of them with their fossil contents, will be found in a paper by myself, "On our Present Knowledge of the Invertebrate Fauna of the Lower Carboniferous or Calciferous Sandstone Series of the Edinburgh neighbourhood," etc.*

A census of the L. Carboniferous fauna met with around Edinburgh gives the following results:—

Brachiopoda,	2 genera,	3 species.
Bivalves,	9 „	13 „
Gasteropoda,	4 „	4 „
Pteropoda,	1 „	1 „
Cephalopoda,	2 „	5 „

Eleven out of the thirteen species of Bivalves are not known to exist with any certainty above in the Carboniferous Limestone; such is the same with only one of the Gasteropods, whilst all the Brachiopoda and Cephalopoda pass upwards. The Lower and Upper Limestone Groups contain the great mass of molluscan life, and as such need not engage any great share of our attention. In one bed alone—the Main Limestone of Dalry—according to Mr R.

* Quart. Jour. Geol. Soc., 1878, xxxiv., pp. 1-26.

Craig's researches, about thirty genera and more than fifty species have been met with.*

In an important paper, "On the First Appearance of Certain Fossils in the Carboniferous Strata around Beith and Dalry,"† Mr Craig has shown that a regular gradation takes place in the appearance of species in the rocks of this district which must be due to some physical causes. The number of Mollusca met with in this basin may be accepted as a fair illustration of that of the Lower Limestone Group generally; the numbers given by Mr Craig are as follows:—

Brachiopoda,	14 genera,	29 species.
Bivalves,	18 „	30 „
Gasteropoda,	10 „	22 „
Cephalopoda,	3 „	7 „

Turning to the Upper Limestone Group we may take as examples the two localities which have been most thoroughly investigated—Robroyston and Orchard. Through the painstaking industry of Messrs Young and Armstrong these two celebrated spots have been thoroughly investigated. The limestones are sparingly fossiliferous as at many other places, but the overlying shales are surprisingly rich. The following are the numbers of each class obtained by Messrs Young and Armstrong:—

	Orchard.‡		Robroyston.§
Brachiopoda,	11 genera.	23 sp.	20 sp.
Lamellibranchiata,	13 „	24 sp.	16 sp.
Gasteropoda,	12 „	24 sp.	26 sp.
Pteropoda,	1 „	2 sp.	1 sp.
Cephalopoda,	5 „	12 sp.	15 sp.

The fossiliferous shale at both localities is particularly rich in Mollusca of the first three classes mentioned rather than other fossils.

* "Sketch of the Carboniferous Basin of Dalry, Ayrshire" (Trans. Geol. Soc., Glasgow, 1869, iii., pt. 2, p. 271).

† *Ibid.*, 1875, v., pt. 1, pp. 36-50.

‡ "Notes on the Fossils of the Orchard Limestone Series" (Trans. Geol. Soc., Glasgow, 1877, v., pt. 2, p. 250).

§ "The Fossils of the Carboniferous Strata of the W. of Scotland" (*Ibid.*, 1874, iv., pt. 3, p. 267).

Many years ago the late Mr J. W. Salter recorded from the Upper Limestone Groups of Valleyfield, near Penicuik, a shell under the name of *Strophalosia striata.** Mr A. Somervail declines to accept this on the ground that *Strophalosia* is not a Carboniferous genus. Had he, however, referred to Mr Davidson's Carboniferous Monograph he would have found this to be simply a synonym for *Productus striatus,* used by Professor Morris.† The latter shell, although not recognised as a Scotch species by Mr Davidson, I believe to occur at the locality mentioned.

Unusual interest is attached to the Mollusca of the two great coal-bearing sub-divisions of the Scotch Carboniferous area, the Middle Coal and Iron, or Edge Coal Group, and the Coal Measures proper. The first has been almost wholly studied in two areas, around Possil and Govan, near Glasgow, in the West, and the neighbourhood of Bo'ness, Linlithgowshire, in the East. As noted by Mr J. Young ‡ there are very few persistent bands of limestone or other calcareous strata, but the series consists of numerous thin seams of free coal, cannel coal, blackband ironstone, beds of bituminous shale, and bands of clay ironstone, etc. This disposition holds good for both areas, and is probably very similar to that of the higher Coal Measures. As a rule the absence of marine fossils and the prevalence of fresh water types is almost as marked a feature as in the Coal Measures, and much more so than in the Calciferous Sandstone Series. This is especially the case in the Possil series, but at rare intervals a return to temporary marine conditions is evidenced by the presence of *Lingula.*§ The Possil Upper Series (Possil Up. Coals and Ironstone) contains no Mollusca, but in the Middle Series (Possil Lr. Coals, etc.) one Brachiopod, *Lingula squamiformis,* occurs very abundantly.‖ On the other hand, the Lower Series of beds (Govan Ironstones) contains a fairly marine fauna, if we reckon from the various localities conjointly, giving us Brachiopoda 4 sp., Bivalves 6

* Mem. Geol. Survey, Scotl., No. 32, p. 142. † Catalogue, 1854, p. 155.

‡ "Notes on the Section of Strata in the Gilmorehill Quarry" (Trans. Geol. Soc., Glasgow, 1869, iii., pt. 2, p. 298).

§ Young, *loc. cit.*, p. 300. ‖ *Ibid.*, pp. 307, 308.

sp., Gasteropoda 10 sp., Cephalopoda 3 sp.* In the Bo'ness Coalfield a similar marine band occurs, forming the roof of the Smithy Coal; here have been met with two Brachiopods, seven Bivalves, and two Gasteropods.† The fauna of the remaining portion of this group is purely fresh water or estuarine, whilst the shale above the Bo'ness Lower Ironstone is crowded with an *Anthracoptera*, a true Coal Measure genus properly speaking.‡ We find in this fact an entire departure from the condition of things in the Possil Series, where there appears to be a singular absence, says Mr Young, of the characteristic bivalves of the Coal Measures.§

In the slaty band Ironstone of Gilmerton and Loanhead in the Edinburgh field, according to the researches of Mr Sommervail, *Lingula squamiformis* occurs to the exclusion of other forms,‖ but this does not hold good of any of the beds in the Bo'ness Coalfield, collected from by Mr James Bennie.

From the fossiliferous Upper Limestone Group we pass to the comparatively unfossiliferous Millstone Grit, previous to again advancing to a more richly provided series, the Coal Measures.

In Fife, the late Mr R. Gibbs found fossils in the Millstone Grit as early as 1860,¶ viz., *Prod. semireticulatus*, *Lingula mytiloides*, a *Modiola*, and a *Macrocheilus*, etc.

Again, the Curly Ironstones of the Wishaw district, at the base of the Millstone Grit, have been found to contain four Brachiopods—*Lingula mytiloides*, *L. squamiformis*, *Orthis resupinata*, and *Streptorhynchus crenistria*.** At about a similar horizon, in the neighbourhood of Douglas, near Lesmahagow, shales and ironstones are met with, containing more than one species of *Anthracosia*. †† In the Gladsmuir Hills the shales under the Curly Ironstones contain *Discina nitida*, *Orthis*, sp., *Streptorhynchus crenistria*, a *Schizodus*, and *Bellerophon decussatus*.‡‡

Mr W. Grossart describes another horizon in this division

* Young, *loc. cit.*, pp. 309, 310.
† Mem. Geol. Survey, Scotl., No. 31, p. 70. ‡ *Ibid.*, p. 69.
§ *Loc. cit.*, pp. 307, 308. ‖ Trans. Geol. Soc., Edinb., 1877, iii., p. 72.
¶ Mem. Geol. Survey, Scotl., No. 32, p. 150. ** *Ibid.*, No. 23, p. 89.
†† *Loc. cit.* ‡‡ Mem. Geol. Survey, Scotl., No. 31, p. 74.

of the Carboniferous System, some distance above the Curly Ironstone. It is a seam of clay ironstone known as the "Ginstone" or "Thomson's Balls," with a well-marked marine fauna, consisting of *Productus martini*, *Discina nitida*, *Lingula mytiloides*, *Leda attenuata*, *Nucula gibbosa*, a *Pleurotomaria*, a *Goniatite*, and *Conularia*.*

According to Messrs Armstrong and Young, the only instance of marine shells in a sandstone, known to them in the West of Scotland, occurs near Glasgow. The sandstone is white, and contains "the remains of several species of Brachiopods, and various other shells, chiefly casts."†

It will be observed from the above facts that the molluscan fauna of the Millstone Grit is, in point of species, the most limited we have met with, and almost wholly consists of Brachiopoda. It is probable that the beds in which these fossils are found represent marine inroads in an otherwise almost entirely fresh-water deposit.

The Coal Measures proper consist of the great mineral bearing series of beds, and an upper section, termed the Red Sandstone Group, which is believed to be quite unfossiliferous.‡

The organic contents of the true Coal Measures consist of fish, reptile and plant remains, with a few crustaceans, insects, and a small development of molluscan life. The latter, with the exception of organisms occupying a few marine bands scattered throughout the series, consist wholly of the characteristic Bivalves, *Anthracosia*, *Anthracoptera*, and *Anthracomya*. Until comparatively recent years marine shells were unknown in the Coal Measures, for we find a Mr R. Craig, writing in the year 1839,§ stating that the Upper Coal Series does not "contain the slightest trace of marine organic remains, the shells found in it being all referable to the fresh-water genera *Modiola*, *Anodonta*, and *Unio*." Later researches, however, have proved this notion to be fallacious,

* Trans. Glasgow Geol. Soc., 1868, iii., pt. 1, p. 108.

† Cat. W. Scot. Foss., p. 48.

‡ Mem. Geol. Survey, Scotl., No. 23, p. 93.

§ "On the Carboniferous Formation of the Lower Ward of Lanarkshire" (Trans. Highland Soc., 1839, vi., p. 345).

for, in 1865, Mr R. W. Skipsey announced the discovery of true marine Carboniferous Limestone fossils in strata 60 fathoms above the Ell Coal, or upwards of 300 fathoms above any hitherto known horizon in the Scotch Carboniferous Series. The fossils are found in brown ironstone nodules, on the Drumpellier estate, near Glasgow, and comprise two Brachiopods (*Productus semireticulatus* and *Discina nitida*), one Pteropod (*Conularia quadrisulcata*), a Gasteropod (*Bellerophon Urei*), and a Bivalve (*Schizodus deltoideus*). This is the uppermost point at which these classes are represented, but below the Ell Coal one or two other instances of a marine condition of things are known. I believe I am correct in stating that the bed discovered by Mr Skipsey on the Drumpellier estate is at a relatively higher position in the Coal Measures than any of the marine bands met with in the English Coal Measures, and containing, at times, a profusely marine fauna.

The base of the Coal Measure in Central Scotland is occupied by a well-marked bed, the Slaty-band Ironstone, as it is called, in which have been found, according to Mr W. Grossart,* *Discina nitida, Lingula mytiloides, Conularia quadrisulcata*, and *Schizodus deltoideus*. So far this is an assemblage of fossils closely allied to that found by Mr Skipsey above the Ell Coal, but the slaty-band contains in addition a *Murchisonia*, a *Nautilus*, and *Anthracoptera modiolaris*. To these Mr A. Macconochie, when collecting for the Geological Survey, added *Bellerophon Urei* and *B. decussatus.*†

At Darngaber Castle, near Hamilton, the same ironstone contains *Lingula mytiloides*, and another apparently nearer to *L. squamiformis* than to the former, and an *Anthracosia.*‡ Lastly, in a marine ironstone and shale close on the base of the Coal Measures at Duntillan Pit, near Shotts Kirk, were found a number of a small *Loxonema* or *Murchisonia*, often pyritised, accompanied by a small *Modiola* and an obscure *Schizodus.*§

* "On the Upper Coal Measures of Lanarkshire" (Trans. Geol. Soc., Glasgow, 1868, iii., pt. 1, p. 107).

† Mem. Geol. Survey, Scotl., No. 31, p. 74.

‡ *Ibid.*, No. 23, p. 89.

§ *Ibid.*, No. 31, p. 80.

We are taught by the researches of the various writers quoted the rapid extinction of the Carboniferous Molluscan fauna after the final deposition of the Upper Limestone Group, its struggle on through the Millstone Grit, its occasional appearance in the Coal Measures, and final extinction before the deposition of the Upper Red Sandstones.

In a very interesting paper by Mr R. W. Skipsey, "On the Range and Occurrence of *Anthracosia* and other shells in the Coal Measures eastward of Glasgow,"* the general range of *Anthracosia* is said to be from the Ell Coal to the Splint Coal, but still further eastward, on into the Central Lanarkshire Coalfield, as shown by Mr Grossart, several species of the genus extend down to the horizon of the Kiltongue Coal.

Mr Macconochie obtained a very peculiar variety of *A. robusta* (?) at Palacecraig, forming large masses in a calcareous sandstone, 6 feet above the Calderbank Ironstone, which occupies the position of the Kiltongue Coal.† Furthermore, a species of *Anthracosia* has been met with in the Lanarkshire Coalfield as low as the shale above the Lower Drumgray Coal,‡ whilst in the Douglas district at least three species of *Anthracosia* are found in a Musselband ironstone not more than 40 or 50 fathoms above the base of the Coal Measures.§

Overlying a large number of the coal beds of the Scotch Measures a "Musselband" occurs, which is almost entirely composed of *Anthracosiæ.* These beds assume two conditions; they are either composed of compressed shells, often breaking up on exposure, or are solid and coherent, held together by a calcareous cement,‖ when they become the so-called Coal Measure Marbles, as, for instance, the "Cambuslang Marble."

There certainly does appear, following the researches of Mr Grossart, a restriction of certain species to certain beds in the Coal Measures, although perhaps not to the extent supposed by some; this is at any rate a question which will require further investigation before any strict rules can be laid down.

* Trans. Geol. Soc., Glasgow, 1866, ii., pt. 2, p. 141.

† Mem. Geol. Survey, Scotl., No. 31, p. 76 ‡ *Ibid.*, p. 75.

§ *Ibid.*, No. 23, p. 90.

‖ Grossart, *loc. cit.*

Mr Skipsey states that the genera *Anthracoptera* and *Anthracomya* are much more generally diffused throughout the Measures, but in all cases they are usually found in most perfect condition in the greyish coloured shales, whilst in the black bituminous shales they seldom occur, and then only in single valves.* *Anthracomya modiolaris,* Mr Grossart tells us, appears to characterise the horizon of the Splint Coal. The same writer has further ascertained that in the celebrated Airdrie Blackband Ironstone, *Anthracosia centralis* is the most abundant species. The same shell predominates in the Virtuewell Coal, but does extend much beyond that horizon.

Much writing has been written and many papers published to prove the marine deposition of the Coal Measures in general, but I take it that the special occurrence of marine bands in the measures prove only, and specially, the occasional occurrence of truly marine conditions. We must look upon the sediments in which the genera *Anthracosia, Anthracoptera,* and *Anthracomya* occur as either of a brackish or a fresh water origin. The probability appears to be, speaking purely from personal experience in a climate where creek and brackish vegetation attains a luxuriant growth, accompanied by a rapid humus-accumulation of soil, that the brackish water theory deserves more attention than any other which has been advanced.

THE PERMIAN CONCHOLOGY OF SCOTLAND.

So far as known to the writer the Permian System, as developed in Scotland, has not yielded any, beyond the most indefinite traces of molluscan life. A few years ago Mr P. Dudgeon, F.R.S.E., of Cargen, forwarded to Professor A. Geikie, F.R.S., a few casts from the Permian beds of the County of Dumfries. Beyond ascertaining the relation of these to some Gasteropod having a depressed spiral, it was found impossible to regard them as more than mere derived Carboniferous fossils, a fact borne out by the nodular-looking concretions in which the casts were preserved.

* Skipsey, *loc. cit.*, p. 143.

Great interest is attached to the subject of COLOUR MARKINGS retained by Palæozoic shells. Although but few have been found in a sufficiently good state of preservation to exhibit this, several instances are on record, especially amongst the Carboniferous Mollusca.

Mr T. Davidson has very truly observed, that "two great helps which recent species afford are almost entirely precluded from the Palæontologist; that is to say, the power of being able to anatomically examine the animal, and the absence of that coloration, which is often of so much assistance in the discrimination of recent shells; and when we reflect how vivid, beautiful, and varied must have been the tints which once adorned the now black and dingy fossil, we are delighted, when, by some fortunate accident, some remains of that colour is faintly preserved upon a shell, which has for almost countless ages been concealed from the sight of man."*

Traces of the original colour have been noticed on several Brachiopods. Thus the shell of *Terebratula hastata*, the largest of the British Carboniferous Terebratulidæ, was marked with stripes, probably of a red colour.† In the possession of these red stripes *T. hastata* resembles the recent forms *Terebratula rubella* and *T. pulchella*. The markings are also similar to those in the Upper Greensand varieties of *T. biplicata* from Cambridge.‡ The best example of *T. hastata*, with stripes of colour, yet found is from Longnor, in Derbyshire, and has been figured by Mr Davidson; § but examples of these markings, less well preserved, have been found in Scotland by Mr J. Young.

The smaller species of *Lingula* common in Scotch Carboniferous strata, *L. mytiloides* (Sby.), Mr Davidson believed to be of a bright green colour,‖ but we have lately described examples of this shell from the Bo'ness Coalfield, found by Mr James Bennie, in which the shell bore distinct traces of

* Geologist, 1860, iii., p. 238.
† Davidson, *ibid.*, 1859, ii., p. 473.
‡ Davidson, Mon. Carb. Brachiopoda, p. 13.
§ Mon., t. 1, f. 6.
‖ Geologist, 1860, iii., p. 234.

radiating and fluctuating dark bands. These undoubtedly represented colour bands on the shell when alive.*

Another unarticulated Brachiopod exhibiting such traces is *Discina nitida* (Phill.). In this instance Mr Young found them to consist of alternate radiating bands of blue and white. The specimens were found at Boghead, near Hamilton.†

Amongst Bivalve Mollusca the genus *Aviculopecten* exhibits this character with the greatest frequency, although colour markings have also been seen on *Myalina.*‡ The pigment ornamentation of Scotch *Aviculopectens* has not been described, although such have been found,§ but specimens from the English mountain limestone have been so. *A. planoradiatus* possessed thin concentric bands passing into blotches, and sometimes assuming a widely zigzag pattern. In *A.? sublobatus* the colour markings are better preserved than in any other shell yet found. They are in the form of radiating brown bands. They may be as few as six or seven, or as many as fourteen or fifteen on one example, passing straight from the beak to the margin, or becoming slightly flexuous in their course. They are also of variable thickness, those near the centre of the shell being the thickest, gradually decreasing to the sides, and separated by intervals of varying breadth on the same shell. They exist as plain bands, or each one bifurcates, or each alternate one does so, or, as in one solitary example, the three central out of the seven bands are split up into three thinner sub-divisions, uniting towards the beak. Occasionally smaller bands are interpolated between the larger, extending and becoming thinner upwards towards the beak, from the margin, but not reaching the former.‖

The remains of colour in the Gasteropoda, or Univalve shells, are of much less common occurrence than even amongst

* Proc. Nat. Hist. Soc., Glasgow, 1881, iv., pt. 2, p. 263.

† Davidson, Suppl. Mon., p. 268.

‡ Young, "On the Occurrence of Shells showing Colour Markings, from the Carboniferous Limestone Strata of the West of Scotland" (Proc. Nat. Hist. Soc., Glasgow, 1867, i., p. 185).

§ Young, *loc. cit.*

‖ Geol. Mag., 1876, iii., p. 151.

the Bivalves. Mr Young mentions *Naticopsis* as having been so found, whilst Dr J. S. Hunter possesses a specimen, in his "Braidwood Collection," of *Tychonia* (*Naticopsis*) *Omaliana* (De Koninck) from the Lingula beds of the Lower Limestone Group, with colour bands preserved.* Professor de Koninck has recently given a figure of his *Naticopsis propinqua*,† exhibiting numerous spiral bands of colour.

The best-marked example of this nature amongst Scotch Carboniferous Univalves is perhaps a small shell found two or three years since by Mr James Bennie, at Craigkelly Quarry, near Burntisland, in the Calciferous Sandstone Series. This has been named *Platyostomella Scotoburdigalensis*,‡ and possesses colour bands on the body whorl only, arranged both horizontally and vertically to the longer axis of the shell, but not in the same individual. The horizontal bands are two in every case, one at the periphery of the whorl, the other lower down towards the base. In the variety with the bands vertical, the latter are much more numerous, and they follow and coincide with the lines of growth.§

Finally the Cephalopoda occasionally show traces of colour on their shells. Mr Young has met with an *Orthoceras* in this condition.

In previous pages we have made some remarks on the STUNTED GROWTH of many of the Scotch Carboniferous Mollusca.

That able Conchologist, the late Mr M'Andrew, has stated, "Although the size obtained by Mollusca may be influenced by various conditions in different localities, as a general rule each species attains its greatest size as well as its greatest number in the latitude best suited to its development." ||

The views of those who have studied the distribution of the shells we are now considering, more particularly the Brachiopoda, appear to coincide in attributing this decreased

* "The Geology of the Carboniferous Strata of Carluke" (Trans. Geol. Soc., Edinb., 1868, i., pt. 1, p. 51).

† Gastéropodes, t. 1, f. 27, 28.

‡ Etheridge, Proc. Roy. Phys. Soc., Edinb., 1880, p. 164. § *Ibid.*

|| See Davidson, Geologist, iii., 1860, p. 237.

growth to (*a*) rapid oscillations in the bed of the Carboniferous sea, or seas, resulting in a sudden increase or decrease of depth; (*b*) change of habitat, brought about by unlooked-for irruptions of muddy sediment on a sea bottom peopled with a molluscan fauna accustomed to purer conditions of life;* (*c*) the necessity for change of food from that on which the species had been accustomed to subsist in more congenial areas; (*d*) changes in climate.

One fact, which tends to confirm the view that irruptions of sediment have been one of the causes at work, is worthy of notice. Mr A. Sommervail has pointed out that wherever the limestones thicken out, or one or more bands come together, there the Brachiopoda become of larger size.

Although the Scotch Carboniferous Mollusca are, as a rule, smaller than their brethren of other Carboniferous areas, their state of preservation is often quite as good, and sometimes superior to the latter. The number of individuals does not appear to have been diminished, but growth simply retarded, whilst the species are certainly less in number than in the other rocks of Carboniferous age.

I. *The History of the Chough* (Fregilus graculus) *in Scotland.* By J. HAMILTON BUCHANAN, Esq.

(Read 15th March 1882.)

Throughout successive ages there have been constant changes going on in the relative numbers of the animal kingdom. Many species which were once common have now become scarce or extinct, and others which were formerly extremely rare are now abundant. In the beginning of the present century, the chough was certainly much more widely and abundantly distributed in Scotland than at present; and, as its range is perhaps becoming narrower with each succeeding year, I venture to offer the following notes on its past distribution to the Society. In collecting my information, I have not confined myself strictly to Scotland, but purpose

* See Armstrong and Young, Cat., 1871, p. 36.

prefacing my remarks with some extracts from old books and manuscripts on the bird's occurrence in Cornwall and other parts of England.

In the "Household Book" of Squire Thomas Kytson of Hengrave, Suffolk, the following entry occurs:

> "1573, May.—In rewarde to Mr Carewe his man, for bringing a Cornish choughe unto my m^res^, ... xijd."

Mr Rodd, in his "Birds of Cornwall," suggests that this compliment may allude to the family arms, in which are three Cornish choughs.

"The Survey of Cornwall," * by Carew, in 1602, contains the following passage: "Amongst which [sea-fowl] jackdaw (the second slaunder of our countrie) shall passe for companie, as frequenting their haunt, though not their diet: I meane not the common daw, but one peculiar to Cornwall, and there-through termed the Cornish chough. His bil is sharpe, long, and red, his legs of the same colour, his feathers blacke, his condition, when he is kept tame, ungratious, in filching and hiding of money and such short ends, somewhat dangerous in carrying stickes of fire." In the edition of the "Survey" published in 1811, Tonkin, the editor, remarks, in a footnote to this passage, that choughs, on account of their beautiful appearance, were often sent as presents.

In Camden's "Britannia," † the writer, in describing St Michael's Mount, says that "in the rocks underneath, as also along the shore, everywhere breedeth the Pyrrhocorax, a kind of crow, with bill and feet red, and not, as Plinie thought, proper to the Alpes only. This bird the inhabitants have found to be an incendarie, and theivish beside; for oftentimes it secretly conveith fire sticks, setting their houses

* The Survey of Cornwall, written by Richard Carew of Antonie, Esquire. London, printed by S. S. for John Jaggard, and are to bee sold neere Temple-barre, at the sign of the Hand and Starre; 1602. Sm. 4to, pp. 160.

† Britain, or a Chorographicall Description of the most Flourishing Kingdomes, England, Scotland, and Ireland, and the Ilands adioyning, out of the depth of Antiquitie: Beavtified with Mappes of the Seuerall Shires of England: Written first in Latine by William Camden Clarenceux, K. of A.: Translated newly into English by Philemon Holland, Doctour in Physick: Finally Revised, Amended, and Enlarged, with sundry Additions by the said Author. Londini [folio], 1610.

afire, and as closely filcheth and hideth little pieces of money."

Mr Rodd is of opinion that this notion is merely copied from Carew, and not derived from personal observation. Perhaps also the bird's red bill and feet may have given rise to the charge of arson.

The next work we come to is Borlasse's "Natural History of Cornwall." * Referring to the chough, this author tells us that "among our Cornish birds the coracias of Willughby, or the pyrrhocorax, deserves principal notice. It is found but rarely and at times in other countries, but constantly in this country, and therefore deservedly among the moderns it has obtained the name of the Cornish chough. . . . Its legs, toes, and bill [are] of a strong vermilion, and the bony substances of these parts clear even to transparency: they are always yellow when the bird is young, and in the hen yellower than in the cock, which different colouring probably made Aldrovandus by mistake (as in Willughby is observed) think those with yellow feet, legs, and bill to be a different *species* from the coracias with red feet; its feathers are of a much richer velvet black than those of any other crow. . . . Very apprehensive of danger, it builds its nests in the cliffs, but neither in the top, as if all danger was from below, nor near the bottom, as if all fears were from above, but in the middle of the most steep precipice; very amusing when kept tame; docile, regular, and constant to its hour for meat; early at roost; in bad weather fond of shelter and seldom seen, but presaging good weather, it enjoys the air on the tops of the houses if tame, if wild, strutting stately along the hills or greens by the sea-side."

The Rev. R. Polwhele, in his "Civil and Military History of Cornwall," † published in 1806, mentions that the chough

* The Natural History of Cornwall; the Air, Climate, Waters, Rivers, Lakes, Sea, and Tides, etc. By William Borlasse, A.M., F.R.S. Folio, pp. 326. Oxford, 1758.

† The Civil and Military History of Cornwall, with Illustrations from Devonshire. By the Rev. R. Polwhele of Polwhele, and Vicar of Manaceau. 4to. London, 1806.

is plentiful in the neighbourhood of the Lizard Point, where it breeds. Apparently its numbers had much diminished, for Mr Edmonds, in his "History of the Land's End District," * published in 1862, says that "this bird has now entirely disappeared from the Land's End district; the last place where it built is the 'funnel' of Tol-Pedn-Penwith."

It will, doubtless, seem somewhat anomalous that, in attempting to sketch the distribution of the chough in North Britain, I should have dwelt so long on its history in Cornwall; but I felt sure that it was necessary to do so in order to treat fully of its occurrences in Scotland. At one time there is no doubt that the bird was comparatively abundantly distributed in many inland districts, breeding in similar situations to those presently occupied by the jackdaw. In the second edition of "Pennant's Tour in Scotland," the chough is referred to as breeding "in the farthest parts of Glenlyon and Auchmore;" but in the "Statistical Account" of these districts, published about thirty years later, no mention is made of the bird. Mr Gray, in his "Birds of the West of Scotland" (p. 162), states that, about the same time as Pennant wrote, "it appears to have frequented the rocks at the Corra Linn Falls on the Clyde." In vol. xv. of the "Old Statistical Account of Scotland," published in 1795, the Rev. James Lapslie, in treating of the ornithology of the parish of Campsie, states that "the red-legged crow is but scarce with us; we seldom meet with above a pair or two in the whole range of the Campsie Falls; when we do meet with them, it is amongst the jackdaws, of which there are a considerable number which haunt our rocks." The chough must, however, have entirely disappeared from this locality early in the present century, as no mention is made of its presence in the "New Statistical Account" published in 1839. I have been told that in bygone years it frequented the Ochil Hills, but, unfortunately, I have no evidence as to the

* The Land's End District; its Antiquities, Natural History, Natural Phenomena, and Scenery: also a brief Memoir of Richard Tresithick, C.E. By Richard Edmonds, late of Penzance, Secretary for Cornwall to the Cambrian Archæological Association; with a Map, Six Plates, and several Woodcuts. 8vo, pp. 266, and index. London and Penzance, 1862.

accuracy of this report. In Mr James Lumsden's "Sketch Paper of the Birds of Loch Lomond and Neighbourhood," published in the *Proceedings* of the Natural History Society of Glasgow in 1876, it is stated that the chough "has been obtained near Bowling;" but, unfortunately, I am unable to fix a date to this occurrence. At one time it was also to be met with in the Clova Hills, Forfarshire, where it is mentioned by Don in his "List of the Birds of Forfarshire;" but, as far as I am aware, it has never occurred in Roxburgh or in any of the South Midland Counties of Scotland. Mr Gray, in his "Birds of the West of Scotland" (pp. 162, 163), makes mention of a specimen which was shot and preserved in Crawfordjohn in Lanarkshire in the winter of 1834, and this is probably the latest instance of the bird being met with in an inland locality in Scotland. Since that date it has been entirely confined to sea coast localities, and even in these situations it is only met with in greatly diminished numbers. Bishop Leslie, in his "De Origine Scotorum," published about 300 years ago, states that in his time it bred on the Berwickshire coast between St Abb's Head and Fast Castle; and this is confirmed by the Rev. A. Baird, in Dr Johnston's address to the Berwickshire Naturalists' Club in 1832. In vol. iii., p. 72, of the "History of the Berwickshire Naturalists' Club," Mr Hepburn, who visited St Abb's Head on an ornithological excursion in June 1851, states that "the interesting chough or red-legged crow is now extinct, except a solitary pair, which I am informed seldom strayed from Fast Castle, a few miles to the eastward of the Head." Turnbull, in 1867, considers that a single pair still frequented this locality, but Mr Gray in 1869 doubts whether it has been seen at Troup Head or St Abb's Head for the last ten or fifteen years. Mr Sim, of Aberdeen, informs me that the chough does not occur on the Aberdeenshire coast; nor, indeed, is it mentioned by Mr Thomas Edward in his "List of the Birds of Morayshire." The Rev. Dr Gordon, of Birnie, in a letter to me last summer, says that neither he nor any of his ornithological friends have ever heard of it being seen in that neighbourhood. In the time of Pennant it inhabited Sutherland, and in Mr Harvie-Brown's "Supple-

mentary Notes on the Birds found Breeding in Sutherland,"* a note is given of a specimen in the Dunrobin Museum, which bears the locality of Dunrobin, but, unfortunately, this example bears no date. Mr A. G. More, in "Ibis" (1865, p. 132), states that he is informed by Mr Dunbar that "the chough inhabits only a few localities in Sutherland." Mr St John, in his "Tour in Sutherland" (vol. i., p. 86), writes of one locality as follows: "Whilst looking for rock pigeons, I saw a few of the red-legged crow or Cornish chough passing from rock to rock, and busily employed about the broken stones searching for food." Mr Harvie-Brown suggests that Mr Dunbar probably referred to the same occasion as he accompanied Mr St John during that excursion. Mr Brown has, however, utterly failed in obtaining any further evidence of the presence of the species, and is inclined to think that the specimens seen by Mr St John were merely accidental visitors. He, however, thinks that as the chough is a species which at one time was much more abundant in Scotland than at the present, it is quite possible that it did breed in Sutherland at the time when Mr St John visited that county. Mr Osgood Mackenzie informs me that he has been unable to find any records of the chough in Ross-shire; but as I have no correspondent from the east of this county, it is possible that they may at one time have existed in the neighbourhood of the Cromarty Firth. Mr Gray, in his "Birds of the West of Scotland," considers that the chough is still to be met with in the west coast of Skye, and Mr Osgood Mackenzie has observed the bird on the Storr Rocks on the same island. Mr Mackenzie has heard that years ago there were numbers in the island of Raasay, but he does not fancy that there are any left there now. Mr Gray suggests that the Skye birds have probably come from the south of the Long Island, where, although now extinct, they were found about fifty years ago by MacGillivray (*vide* vol. ii., p. 323, of the "Edinburgh Journal of Natural Geographical Science"). I have been informed that it is no longer to be met with in Tyree or Rum, and I have been unable to obtain any evidence of its presence in Mull,

* Vol. iii., pt. iii., Proc. Nat. Hist. Soc., Glasgow, p. 239.

Colonsay, or Jura of late years; but there is in Mr Smellie Watson's "Egg Book" reference made to a chough shot in Mull in February 1838. It is not now found on the island of Lismore, at the mouth of Loch Linnhe, where Mr Gray states that flocks existed about the beginning of the present century. In vol. xiv. of the "Old Statistical Account of Scotland," published in 1795, Mr Macfarlane, in dealing with the history of the seafowl of the parishes of Kilbrandon and Kilchattan, states that "all the wild and tame fowls commonly seen on other parts of Scotland are frequently seen upon this coast; and some that are now rare, particularly the jackdaw, with red bill and feet, hatches in this country." In 1793 the chough evidently occurred in Giga and Cara, Argyllshire, as Mr Fraser, in writing an account of the zoology of this parish for the "Old Statistical Account of Scotland," states as follows: . . . "Jackdaws are very numerous. Of the last there are two kinds—one with a dark blue head, all the rest black; another with red feet, having the body and head black." Mr Graham, in his "Birds of Iona," published in the "Naturalist" for 1852, says that there are three pairs of these birds constantly resident upon the island. It is perhaps nowhere so abundant in Scotland as in Islay, and from recent accounts its numbers do not appear to be diminishing. Mr Gray has informed me that at one time it was common in Arran, but in his "Birds of the West of Scotland" he writes that a pair wàs shot in 1863, and he has been assured that no choughs have been seen there since. It is also met with at Ballantrae in the south of Ayrshire, but it is apparently almost or quite extinct on the confines of that county and Wigtown. It probably occurs sparingly at Burrow Head and on the opposite shores of Kirkcudbright, as I am informed by the Rev. G. Wilson. Mr Bell, in the Royal Physical Society's *Proceedings* for 1859-60, states that the chough is common in the neighbourhood of Stranraer, building on cliffs and in caves along with his mischievous companion the jackdaw; but it is certain that in this locality, as in most of the rest, it has greatly decreased in numbers of late years.

In conclusion, I would urge on proprietors on whose

estates this bird still occurs to do all in their power to prevent its extermination. There is no doubt that its numbers have decreased very materially of late years, even in favourable localities for its habitation. Some have attributed this to the increase of the jackdaw, which has driven the choughs from their breeding haunts. It is not my intention to discuss this matter at length now, but an instance or two may be quoted where these birds reside together on a friendly footing. Mr Graham, in his "Birds of Iona," published in the "Naturalist" for 1852, states that "these birds (choughs) always maintain a friendly footing with the jackdaws, associating with them in their feeding excursions, and sometimes accompanying them home—indeed, one pair is permitted to breed along with the daws on St Columba's Tower." An anonymous author in the "Naturalist" for 1850 denies that the jackdaw is displacing the chough, and instances a locality in Pembrokeshire where they breed harmoniously together. Mr Gray, however, is of opinion that in the localities which he has visited, the decrease in the numbers of the chough is only to be accounted for by the ravages made on its nesting-places by the yearly increasing jackdaw. Be this as it may, there is little doubt that the bird has suffered much of late years at the hands of gamekeepers and others, who have ruthlessly slaughtered it at every opportunity; and unless proprietors delete the bird's name from their vermin list, and use their utmost endeavours to preserve it in every possible way, there can be little doubt that ere long it will cease to inhabit these islands.

I have to mention my indebtedness to Mr Harvie-Brown and Mr Gray, both of whom have given me great assistance in the collection of material for the foregoing paper.

II. *On the Birds of Glenurquhart, Inverness-shire.* By Archibald Craig, Jun., Esq.

(Read 15th March 1882.)

There are few districts in Scotland which offer greater scope for the study of ornithology than Glenurquhart,

although one unacquainted with the locality might be almost excused for doubting this statement when he considered that it was nearly 200 miles north of Edinburgh, and completely surrounded by high mountains, whose snowy summits, even in summer, bear evidence to the extreme coldness of the atmosphere a few thousand feet above the sea-level, coupled with the fact of their receiving a share of almost every blast that passes overhead. Those very hills, however, are probably one of the chief reasons why bird life should be so abundant, as they shield the Glen from the biting easterly and northerly winds, and as a natural consequence, when to this advantage is added a fertile soil, woods flourish and cultivation progresses in a measure unchecked. The lower parts of the Glen and Strath are laid out in well-tilled farms, broken up by thickets of wood, some natural, composed of birch and alder, oak and ash, etc., while others again of firs have been planted. Two fair-sized rivers, called respectively the Enerick and Coiltie, water the glen and strath; these in turn receiving numerous tributaries, in the shape of small burns which have their origin among the muirs above, and which find their way down every little hollow that furrows the hill-side.

Many of the mountain slopes are entirely covered with wood, and apart altogether from their natural beauties, which are unsurpassed, give shelter to a great variety of insessorial birds; while, on the other hand, many of the hill-sides are wholly composed of small farms or crofts, making a breeding ground for others, such as the wheatear, whinchat, skylark, etc., which prefer the open country to the forests.

Round the margin of Urquhart Bay, where the two rivers empty their waters into Loch Ness, is a small tract of swampy ground, studded here and there with thickets of alder, tenanted by different aquatic species, such as coots, moorhens, etc., besides various buntings and warblers; and above the line of cultivation there is a vast expanse of barren moorland, swelling into rocky heath-covered hills, and dotted with small tarns, a favourite resort of such birds as require extreme solitude for the successful rearing of their broods.

[illegible] glens in Scotland which combine in them-

selves such a variety of scenery, every grade being more or less represented, from the richly cultivated lands of its lower parts to the barren desolate waste of the higher portions; but without going further into details, this slight sketch will be sufficient to show what is intended—namely, that a district containing so many opposite characteristics, and so favoured by nature in other respects, is more than likely to be correspondingly rich in its bird life. That this is correct I trust the following list will amply prove. With regard to the names of birds included in it, I have been careful to avoid putting down any about whose occurrence there is any doubt —the greater proportion having actually come under my own observation; and those which I have not seen are inserted on the authority of some friends whose testimony is thoroughly reliable.

GOLDEN EAGLE (*Aquila chrysætus*).

A pair of these magnificent birds have bred for some years on the precipitous slope of one of the spurs of Mealfourvonie, a mountain about 3000 feet in altitude, and thus might have continued to do so had not an accident befallen one of the birds, which resulted in its death, when the remaining one disappeared from the locality, and, as far as I am aware, it has not yet returned with another mate.

KITE (*Milvus regalis*).

A pair of these birds nested in the woods of Balmacaan a year or two previous to 1865. They were shot, and are now in the collection at Balmacaan House. As far as I can learn these were the last kites observed in the Glen.

BUZZARD (*Buteo vulgaris*).

At one time by no means uncommon, and still occurring occasionally, notwithstanding the inveterate hostility of the numerous gamekeepers on the estate, whose mission in life seems to consist in the destruction of every living thing which actually is or is supposed to be detrimental to "game." The same cause militates against the increase, or one might almost say the very existence, of all birds of prey, including

hawks, owls, jays, crows, etc., whose numbers have been so thinned by the process that few are left to breed in the district, although the ground is admirably suited to their requirements. This destructive policy on the part of the sporting community is fast depriving the ornithologist of one of his greatest pleasures—namely, the studying from actual observation the habits of the *Falconidæ* and other birds of prey; but it is pleasant to learn that, in a few quarters at least, a reaction seems to be setting in, and many proprietors and lessees of shootings are now attempting to preserve what they formerly did their utmost to exterminate; and there seems room for hoping that the remnant who have managed to exist through all these years of persecution may in time flourish once more in their native wilds.

ROUGH-LEGGED BUZZARD (*Buteo lagopus*).

Another buzzard has been found at rare intervals, which is apparently this species.

PEREGRINE FALCON (*Falco peregrinus*).

Much commoner than the two buzzards. Its principal breeding ground is in the vicinity of Mealfourvonie and among the hills to the north of Loch Meikley, a wild district lying between Strath-Glass and Glenurquhart.

MERLIN (*Falco æsalon*).

Now very rare. Is chiefly found in the neighbourhood of Abriachan, a most picturesque and rugged range of mountain slopes running for several miles along the west side of Loch Ness, which, from its solitary nature and bold characteristics, harbours by far the greater proportion of all the rarer birds that inhabit the district.

KESTREL (*Falco tinnunculus*).

Of frequent occurrence in th[illegible] rts of the Glen, such as the Glens of D[illegible] although comparatively harmless i[illegible] ry occasion.

Sparrow Hawk (*Accipiter nisus*).

One of the few hawks which seems to maintain its ground. This bird loses nothing for want of pluck, as it snaps up the young pheasants from under the very eyes of the keepers attending to the pheasantry. It sits sometimes on a high part of a tree, taking a survey of the ground, and when the moment appears favourable it flies down with great velocity, and takes off the young bird, happily before the man has time to seize his gun.

Short-eared Owl (*Asio accipitrinus*).

Not at all common.

Long-eared Owl (*Asio otus*).

The same remark applies to this species, although it is seen now and again; on one occasion for certain within the last three years.

Barn Owl (*Aluco flammeus*).

Almost entirely thinned out by trapping, but, when observed is usually to be found residing on a hill called Craig Mony, one of those curious masses of conglomerate, which rises out of a dense pine wood, and which is not an uncommon feature in many parts of the Highlands. In the darkest part of the wood, immediately surrounding the base of this rock, the owls roost during the day, but unless frightened out of their retreat by an excess of gun shots or other means there is scarcely any chance of seeing them.

Tawny Owl (*Strix aluco*).

This owl is still rather numerous, notwithstanding gamekeepers, with their guns, pole traps, etc., and in the calm nights of October and November particularly, it may be heard giving vent to its mournful cry. Many people dislike the hooting of this bird, but to my mind it lends a weird kind of charm to the surroundings, especially on one of these still moonlight nights in the late autumn, when the slightest sound is audible. On such an occasion you can hear them

answering each other from all points of the Glen, at distances varying from one to three or four miles.

Their chief haunt is a long stretch of wood on the south side of the strath, but during the day they sometimes sleep among the alder clumps which margin the loch, and in thick holly trees scattered up and down the woods.

SNOWY OWL (*Nyctea scandiaca*).

This bird is given entirely on the authority of a friend, on whose accuracy I can place the utmost reliance. He only saw it once, however, and that was in the wood of Abriachan. I was rather inclined to suppose at first that what he saw was the barn owl, but from the description of its size and plumage I am justified in concluding that it was none other than the snowy owl.

RAVEN (*Corvus corax*).

A pair were seen two years ago haunting the neighbourhood of Mealfourvonie, and were believed to be breeding there.

CARRION CROW (*Corvus corone*).

Seldom seen.

HOODED CROW (*Corvus cornix*).

Tolerably common. They build on a high hill called Craig-na, covered with a pine forest, in the Abriachan district also, and regularly at one time on a few stunted trees which grow on a small rocky island in Loch Aslich, a little lake far removed from human habitation, in the heart of one of the wildest and most picturesque solitudes of a district where such scenes are no rarity. This crow is the most cunning of all in the choice of a situation for the nest. Although at first sight it would scarcely be imagined, the tree chosen is almost invariably in such a position that the female on the nest can command a view of every possible approach, and when the would-be destroyer imagines that he is getting quite close up without disturbing the bird, he finds to his chagrin that she has taken the alarm long before, and pre-

sently is heard croaking angrily with her mate at some distance. When the young are newly hatched, however, she sits very close, and the keepers sometimes kill the old bird and the nestlings by firing through the bottom of the nest. Although extremely rough and coarse-looking outwardly, the inside of the nest is constructed with a much greater idea of comfort than that of the rook, being warmly lined with feathers and other soft substances. The eggs vary very much in shape, some being more conical than others, and sometimes out of four eggs taken from the same nest, no two are exact in size and form.

Rook (*Corvus frugilegus*).

Great numbers frequent the district during autumn, and, in fact, are to be seen more or less at all times of the year but curiously enough do not build anywhere in the Glen, although a rookery existed at one time in a pine wood not far from the village of Drumnadrochit, but whether deserted by the crows themselves, or pulled down by the people, I cannot remember. The nearest rookery now is in the Beauly district, ten or twelve miles distant.

Jackdaw (*Corvus monedula*).

A colony of these noisy birds exists in one of the many gorges of Abriachan, certainly one of the grandest, as well as the most secure, situations that could be chosen. At a height of say roughly 1800 feet above the level of Loch Ness, a high waterfall plunges into a deep chasm, the sides of which are perpendicular in the truest sense, and perhaps about 200 feet in height. In the clefts of these rocks the jackdaws build, as secure from bird-nesting youths as if they were in an uninhabited island, but at the same time they are not absolutely safe from any one who possesses and can use a gun. They are not much molested, however, as the risk of shooting them is no uncommon one; the slightest false step would inevitably prove fatal. There are few more picturesque spots in the whole district than this " home of the jackdaws."

MAGPIE (*Pica rustica*).

Only occurs as a straggler, and I do not know of any instance where they have built for many years, their raids among the eggs of game birds being their death-warrant on every occasion.

JAY (*Garrulus glandarius*).

Seems now to be extinct, although it must have occurred at one time, as stuffed specimens shot on the estate are to be seen in Balmacaan House, the residence of the proprietor, the Earl of Seafield.

GREAT TIT (*Parus major*).

Not so common as its smaller allies, but still fairly abundant. Like the blue tit, it prefers the woods in the low grounds to those on the hill-sides, and is to be seen in greatest abundance in the plantations around Balmacaan House, and in a thick tangled stretch of wood, used as a game preserve, running inwards from the shores of Loch Ness. It is even more pugnacious than its lesser brethren, and bites most furiously when caught. Like the robin, it has a knack of alighting on the limed twigs used by bird-catchers; and on those occasions when it finds itself deprived of the power to fly off, it gives utterance to a continued and angry chattering, and even after it is restored to liberty, it still lingers about the locality venting its complaints.

BLUE TIT (*Parus cœruleus*).

The most beautifully plumaged of all the tits, and I think I am correct in saying, the most familiarised to the presence of man.

One day during early spring I was attracted, while standing in a fir wood, by a tolerably loud tapping noise close at hand, which I might have taken for that of the woodpecker had I not known that the bird did not exist in Glen-urquhart, until, after waiting silently for a long time endeavouring to ascertain the cause, I at last discovered a blue tit, who all the while had been close at my elbow, hammering

with great industry the branch of a larch, from which he was suspended back downwards. So intent was he on his work, that he either did not notice or did not care for my presence, but still continued at his task. On examining the branch after he flew off, I failed to discover what was his object for so much exertion; perhaps his superior eye saw what mine could not detect—some hidden insect treasure in the bark.

This species bears an unenviable reputation among the natives of Glenurquhart, as it is said to destroy great numbers of hive bees.

COLE TIT (*Parus ater*).

By far the most numerous, and found in great numbers in all the fir and pine plantations. On Craig-na, already mentioned, great flocks of them may be seen, associated at times with goldcrests and tree creepers; and in the other woods of the strath they often accompany siskins and redpoles, who in turn follow in the wake of the crossbills.

MARSH TIT (*Parus palustris*).

I have been informed by George Muirhead, Esq., Paxton, that he observed this bird among the spruce trees near Balmacaan in 1866 and 1867.

Obs.—I have as yet been unable to satisfy myself on the point of the existence of the crested tit, although curiously enough it is a constant resident on another of Lord Seafield's estates in Strathspey.

LONG-TAILED TIT (*Acredula caudata*).

Barely so common as the three former, but still to be met with in every suitable wood.

Not very far from Balmacaan House there is a curious lonely little burying-ground hidden in a birch-wood, and close beside it is a stagnant pool called by a Gaelic name, signifying the "Pool of Blood," around which hovers the traditions of a great battle fought between rival clans. This spot, hallowed as it is by the near presence of the dead, and interesting, besides, on account of its historic memories, is all

the more so to the ornithologist, as it is, without exception, the finest point of vantage in the whole Glen for observing the ways and manners of almost all the small birds which inhabit the district. In the early mornings, but more particularly towards the close of the day, they come there in flocks to slake their thirst and perform their ablutions, so that one has nothing to do but rest quietly in close proximity to the pool, and he will have the satisfaction of seeing a greater number of species in a few hours than he would manage to do in whole days of scouring the district. The long-tailed tits in particular haunt the tops of the trees in the evenings, halting about the vicinity of the pool for a time while *en route* for their roosting ground.

SPOTTED FLYCATCHER (*Muscicapa grisola*).

Frequently to be seen in summer sitting on the dykes and wire fences which enclose the fields, and readily recognised by its manner of darting out a few yards into the air after an insect, and as quickly returning to its perch.

KINGFISHER (*Alcedo ispida*).

Although found much farther north, I cannot remember having seen it in Glenurquhart; yet the people assert that it has been seen on the banks of the river Enerick. In many country districts of Scotland the water ouzel and the common sandpiper go by the names of kingfisher; probably, therefore, the mistake may have originated in the confusion of either of those two birds with *Alcedo ispida*.

HOOPOE (*Upupa epops*).

It was related a few years ago in the newspapers that a pair of these birds was seen by a gentleman, while fishing in the river Glass, on the property of Lord Lovat, about twelve miles distant from Glenurquhart. Being observed so close to the district, I have included the hoopoe in the list, as there is little doubt of the truth of the newspaper account.

CREEPER (*Certhia familiaris*).

Very common; seen at times singly and in pairs, but more frequently keeping company with the tits and goldcrests—the latter searching the branches more particularly, while the creeper turns his attention to the main stem.

CUCKOO (*Cuculus canorus*).

Heard during the season in all parts of the Glen, but is more plentiful along the hill-sides of Abriachan. The young birds seem comparatively fearless, and will permit a near approach; but the old birds are very wary indeed, necessitating a good deal of strategy on the part of the observer, should he desire to get close to them.

NIGHTJAR (*Caprimulgus europœus*).

The keepers sometimes come upon these birds in June and July, during the day, among the heather, but only by chance, as they don't care to rise unless in danger of being trod upon.

SWIFT (*Cypselus apus*).

A few pairs come regularly to the Glen, and build somewhere about the high parts of Balmacaan House. They are also to be seen flying in the vicinity of Drumnadrochit village, but are not numerous.

CHIMNEY SWALLOW (*Hirundo rustica*).

Not so plentiful as the next species, the

HOUSE MARTIN (*Chelidon urbica*),

which is a favourite there, as it is everywhere else. It builds in great numbers among the ruins of Urquhart Castle, chiefly amidst the battlements on the top of the old tower.

SAND MARTIN (*Cotile riparia*).

The commonest of all the swallows. On their first arrival, they fly over the waters of Urquhart Bay, and also over Loch Meikley, a pretty lake about six miles up the Glen. They have numerous breeding stations about the sides of the

Enerick, also in banks behind the village of Milltown and the clachan of Bullburn.

PIED WAGTAIL (*Motacilla lugubris*).

Found about the river sides, farm yards, and following the plough in spring time. It possesses a sort of song, sweet enough to the ear, but rather wanting in variety, which it usually sings in early spring, while running along dykes or the roofs of houses.

GREY WAGTAIL (*Motacilla sulphurea*).

Common enough at one time, but not so plentiful of late. This may perhaps be accounted for by the extreme severity of the winters of 1879 and 1880, which may have killed out those birds that did not migrate southwards.

Obs.—Having mentioned those winters, I would like to remark here that the effects were so disastrous to the native birds as hardly to be credible unless one had witnessed them. Last spring (1881), before the migrants arrived, in many parts of the Glen there was scarcely a bird to be seen; thrushes of all kinds, siskins and redpoles, seemed to have been destroyed. The only birds which apparently had weathered the storms were the sparrows and chaffinches, and even these were greatly diminished in numbers. One could walk through woods and hardly ever hear a chirp, whereas in former years the whole country side was swarming with songsters. Snow buntings were so pushed by hunger as actually to come down to the back parts of the villages in the low grounds, and fraternise with the sparrows; blackbirds sat on the trees about the hamlets, puffed out into round, ball-like forms, watching for any chance morsel that might be thrown out; robins also took up their position on the palings which enclosed the little patches of garden ground—and both birds were so tame and desperate with famine that nothing short of stones thrown at them would make them relinquish their posts. Multitudes perished; and this need excite no wonder, as for several mornings the thermometer registered six, and even as low as twelve, degrees below zero, Fahrenheit. The only birds which

maintained their position were the crossbills, as they could always get plenty of cones on the trees, although the ground lay deep with snow.

MEADOW PIPIT (*Anthus pratensis*).

As numerous in the swampy grounds adjoining Loch Ness as it is on the moors above. I should say that this species is the commonest of any during the breeding season on the high grounds, as one can hardly walk in any direction on the moors, especially on those parts which border on the highest limits of cultivation, without disturbing many pairs.

TREE PIPIT (*Anthus trivialis*).

Arrives about the end of April or beginning of May, and attracts attention by the peculiar manner in which it rises off a tree, and descends with outspread wings, all the while singing with animation. The song is not very great in quantity, but what there is is of fine quality. It breeds chiefly in the woods at Pitkerrald and Achmony.

Obs.—It is reported that the Woodlark (*Alauda arborea*) has been seen in the same woods, but this requires confirmation.

SKYLARK (*Alauda arvensis*).

Breeds almost exclusively on the higher parts, where the small crofts unite with the moorland, but is not nearly so common as the meadow pipit. The cause of this is not easily determined; certainly it is not owing to the depredations of starlings, as has been maintained by many newspaper correspondents, these birds not being very plentiful, although gradually on the increase, in Glenurquhart as elsewhere. A gentleman resident there informs me he has seen the ring ouzel destroying the eggs of the meadow pipit, but never knew an instance where the starling devoured the eggs or young of the skylark. Both birds most likely are guilty at times, but it is probable such cases are the exception and not the rule. So far as Glenurquhart is concerned, I fear it is only too true that skylarks are diminishing.

Corn Bunting (*Emberiza miliaria*).

Frequents a marshy strip of ground running parallel to the main road from Templehouse to Kerrowdown farm, and in spring may be seen sitting on the top of a few small trees planted along the roadside, busily engaged in uttering what passes muster with it for a love song. At no time very numerous, a few are always resident, but from the gradual disappearance of the old ditches and moist places, owing to the superior drainage system, the bird is gradually disappearing, the marshy ground already mentioned being, to the best of my knowledge, the only place where it now breeds.

Reed Bunting (*Emberiza schœniclus*).

Very common in spring and summer about the same place, and frequently to be seen sitting on the trees with chaffinches, greenfinches, and yellowhammers; never, however, very far from the marsh.

Yellow Bunting (*Emberiza citrinella*).

One would hardly suppose that this most beautiful and interesting bird was an object of detestation, but so it is. The superstitious natives believe that it is the handiwork of the arch enemy himself, and also that it is the duty of every professing Christian to hate it in consequence. It is right to state, however, that the feeling against it is dying out, although in some quarters the animosity is still very strong.

Snow Bunting (*Plectrophanes nivalis*).

Coming at a season of year when bird life is scarce, and giving some animation to the usual dead and dreary winter scene, the snow bunting is on that account doubly welcome. After a severe snowstorm the birds apparently flock together, and are driven by hunger off the moors down to the lower grounds; but unless, as was the case last winter (1880-81), the storm is prolonged for many days, they seldom venture lower than the most upland farms. These buntings seem to be in their element during a storm, if we can judge from the fact of their circling round and round at no great height

above the ground while the blast is blowing its keenest, all the while chirping to each other in musical notes, and few more interesting sights are to be seen than a flock enjoying themselves at a time when every other living creature is glad to seek the nearest shelter from the inhospitable "nor'-easters" that blow over the moors. They are not much afraid of human beings, and during a lull in the storm one may approach within a few yards of the spot where they are feeding quite unregarded by the birds themselves. Instances are recorded by various authors of their breeding in Scotland, and a pair were seen on Craig-na by a gentleman, many weeks after the great flocks had migrated, but he was unable to ascertain if they reared a brood.

CHAFFINCH (*Fringilla cœlebs*).

Probably the commonest bird save the house sparrow, and to be found in every quarter of the Glen, even in the highest pine woods, such as those on Craig-na, Craig-Mony, etc. It has a habit of uttering a sharp note on the approach of any one from whose presence it augurs danger, which has the effect of putting all the birds in the immediate neighbourhood on the alert, and consequently it often happens that if one is attempting to approach near enough in order to watch the habits of another species, his purpose is defeated by the wary chaffinch. Among its varied notes I have heard it utter one resembling very closely the call of the redstart.

MOUNTAIN FINCH (*Fringilla montifringilla*).

TREE SPARROW (*Passer montanus*).

The existence of this species is rather dubious. I saw a pair of birds one day at Pitkerrald, near Drumnadrochit, which seemed to me to be the *Passer montanus*, but being unable to procure at present sufficient confirmatory evidence of its occurrence I should not care to say positively that it inhabits the district, although I have little doubt that it will be found to do so.

HOUSE SPARROW (*Passer domesticus*).

Abundant about farm steadings and in the surrounding fields, evidently greatly on the increase of late years, much to the annoyance of the farming community, whose grievances, if we can credit their own statements, are "legion."

GREENFINCH (*Coccothraustes chloris*).

Very numerous. Builds about the gardens of Balmacaan House, also in the fir plantations, and towards evening in the spring time it comes in flocks to roost among the shrubs and laurels of the former place. One of their notes is not unlike that of the crossbill, especially noticeable when a number suddenly rise off a tree; and another similarity that attracts attention is to be seen in individuals only, viz., a solitary bird frequently sitting on the highest point of a fir tree, basking in the sun, with puffed-out feathers—a common habit among crossbills also. Some show the yellow on the wings and breast much brighter than others. One extraordinarily brilliant specimen that used to frequent the road side near Templehouse, was believed by the country people to be a cross between an escaped canary and a greenfinch, which, however, was a mistake.

GOLDFINCH (*Carduelis elegans*).

By no means rare fifteen or twenty years ago, but now extinct, the reason of which may be attributed to two causes —bird catchers on the one hand, and on the other the improved style of farming having eradicated thistles and various weeds, on the seeds of which they fed to a certain extent. The disappearance of the birds has been gradual.

SISKIN (*Carduelis spinus*).

Some years this species abounds, in others again it is rare, although a few are always in the district. Great numbers breed at times in the fir plantings, especially in those near the parish church; but the nest is not often found, being well concealed by the dense foliage of the spruce trees. In May 1880 I saw a pair beginning to build on a fir close

to the public road; but after the first day or so they seemed to change their minds, and did not proceed further with the nest, in all likelihood having been frightened by passers-by. This is a favourite cage bird with the Glen people; and in April or May they are easily caught by means of limed sticks and a call bird. It is rather an interesting sight to watch their capture. If the call bird is a female, the male who is attracted by her cry circles round and round overhead, with wings outspread, pouring out his song with his utmost power, and gradually narrowing the circle until he finally alights on the cage or the ground close beside, sometimes settling on the limed twigs at once, and on other occasions running round the cage, still whistling, in vain endeavours to find an entrance. Few birds take so kindly to confinement or become so tame as the siskin. Its otherwise sweet song is spoiled by a harsh screech interjected every now and then, which peculiarity renders it an easy matter to distinguish between its singing and that of other small birds. Flocks of siskins and redpoles often follow the crossbills in their journeys through the woods, and take advantage of the broken fir cones from which the seeds have not been all extracted.

REDPOLE (*Linota rufescens*).

Is abundant. Its habits are much akin to those of the siskin, and is readily caught by bird-catchers. Its cry, rather loud for such a small bird, has a dull guttural sound, although that expression hardly conveys the proper effect. The notes of birds are best learned from actual hearing, as they can never be accurately represented by any written description. A knowledge of the various distinctive notes is of the utmost importance to the ornithologist, as without it many species may be passed unnoticed.

MOUNTAIN LINNET (*Linota flavirostris*).

Common on the high and moorland parts, and easily distinguished from the former by its longer tail and the absence of the red colour on the breast and crown of the head. The rump has a carmine hue, but this cannot be seen unless the

bird is very close at hand. Their call and short song is pleasant, and in their natures they seem sociable, as even at the breeding time they may be seen in little bands of six or more, playing and feeding together.

Bullfinch (*Pyrrhula Europöea*).

In the Abriachan birch woods, and in fact more or less all over the Glen, the plaintive note of the bullfinch may be heard during spring, at which time they call more frequently than at other seasons. I regret to say that great numbers are destroyed every spring by game-keepers and gardeners.

Crossbill (*Loxia curvirostra*).

The most curious and interesting of all birds that inhabit Glenurquhart. In order to do justice to them, a paper would require to be entirely devoted to their history and habits; but in this instance I have only jotted down one or two of the most prominent features in connection with their appearances in the district. They have been known to occur at intervals for many years, but lately have taken up their abode permanently, although disappearing now and again for a short time, when it is believed they retire to the higher and more distant pine woods in search of food. Beyond all doubt, they are now breeding freely there, as in March and April numerous flocks, composed chiefly of young birds, fly about the wood near the parish church, uniting in autumn and winter with other flocks, and forming congregations of as many as sixty or seventy. As is well known, their staple diet is the seeds of fir-cones, larch apparently being the favourite. There can be no more interesting or instructive sight than to watch their manner of attacking the cones, and as they are very tame and fearless, this is easily accomplished. They will allow a person to stand at the foot of the tree on which they are feeding, or even to climb up among the branches in many cases, quite regardless of his presence. Of course one can hardly get close enough to see how the seed is extracted, but this can be done effectively if a specimen be secured and caged. Happening to possess two very tame ones, I have had ample opportunity

of watching their ways, and will attempt to describe as briefly as possible their mode of procuring the seed. As the name implies, the mandibles are crossed, sometimes to the right and sometimes to the left, there seeming to be no rule for this peculiarity, nor yet is the manner of crossing a distinguishing mark of the sex, both sexes being subject to this variation. The lower mandible has a lateral motion as well as a perpendicular, this double action giving the bird an extra purchase, as the sequel will show. It inserts the beak under the sheath of the cone, moves the lower bill to the side, at same time opening its mouth, which has the desired effect of raising up the scale; then it pushes out its long tongue, which has a sharp bony extremity, and by its means pulls out the seed. When the scale is stiff, it cuts it open with the edges of the bill, just in the same way that one would use a pair of scissors. I ought to have mentioned that the cone, if not too heavy, is nipped off the tree, and held by the feet against the branch while the operation is going on, but when too large, it hangs on to the cone itself in all sorts of positions like a tit or siskin. While feeding in a flock, they keep speaking to each other in a sort of chuckle, but during flight the note is a sharp clear ring quite unlike the call of any other species. The male sings usually on the highest point of a tree, and although his musical talents are not of a very high order, his attempt at melody cannot fail to give pleasure to the listener; it is so different from the song of all our native birds. Like many others, the crossbill can imitate the warblings of different species, one which I procured when young having acquired the song of a canary, besides stray notes of the siskin, and a few of the more prominent calls of his own species, which he still remembers. Whether it imitates other birds in a wild state, I am unable to say, but am inclined to believe that young birds alone acquire other songs in captivity, the old birds being thoroughly confirmed in their natural notes. If properly treated when caught, no bird gets accustomed to cage life more readily, or is more docile and affectionate. They resemble the parrot a good deal in their ways, climbing about the wires of the cage, and tearing the woodwork to pieces, and the amount of

ingenuity they exercise in opening the door, untwisting the binding wires, etc., is wonderful. The plumage varies a good deal, but hardly so much, I think, as many well known ornithological writers describe. The only nest I ever found was composed of lichen-covered twigs of the larch, fibrous roots, and moss, and was placed in a spruce tree at the junction of a branch with the main stem. It had a partial roof of twigs covering half of the nest, but this may have been exceptional, as other nests procured in Scotland do not seem to possess this semi-arched structure.

STARLING (*Sturnus vulgaris*).

Builds about the chimneys of Balmacaan House and Clunebeg. Not very numerous, but, as elsewhere, rapidly increasing.

WATER OUZEL (*Cinclus aquaticus*).

Frequents the beds of the Enerick and Divach burns, and builds sometimes in the retaining wall close to the Bridge of Drumnadrochit, but is not nearly so plentiful as in the Lowlands. At all times a welcome and interesting resident, it is all the more so there, owing to its comparative scarcity.

MISSEL THRUSH (*Turdus viscivorus*).

Used to be a well-known species, and no doubt will continue so, when the disastrous effects of the cold winters have been overcome by time.

FIELDFARE (*Turdus pilaris*).

Arrives in flocks about the end of October, at which time they may be seen greedily devouring the few rowans that have not been stripped off by the non-migratory birds, such as blackbirds, bullfinches, greenfinches, etc. At that time they can be easily approached, but later on in the year it is a matter of some difficulty to get within gun-shot.

REDWING (*Turdus iliacus*).

Comes about the same time as the former, and in habits is similar.

MAVIS (*Turdus musicus*).

The same thinning of their ranks has taken place as in the case of the missel thrush. During last May (1881) I did not see more than six song-thrushes in a fortnight, whereas in former years they could be heard singing in every wood. They are evidently more tender and unable to stand the rigours of winter to the same extent as the next species.

BLACKBIRD (*Turdus merula*).

Common everywhere in the lower grounds, particularly among the shrubberies at Balmacaan and the other large houses over the Glen. They are most prolific birds, sometimes rearing as many as three broods in a season, much to the annoyance of the gardeners, who hate them even more cordially than they do the bullfinch. Happily they are not so easily shot as the former, being endowed with much greater ideas of self-preservation, which saves them from suffering much diminution.

RING OUZEL (*Turdus torquatus*).

On the rugged hill-sides of Abriachan, where birch and hazel trees mingle with the broken masses of rock, on the heathery slopes above the tree limit, in the ravines which intersect the great expanse of moorland, in fact, amidst scenes of extreme solitude and wild grandeur, the ring ouzels make their home. On the rocky face of Craig-na these birds build their nest amidst the juniper bushes, and on the banks of a burn which flows out of a little tarn, called Loch Glanny, two or three pairs regularly take up their abode every spring. I doubt very much if there is any moorland bird (except the curlew) that gives an intruder a wider berth than the ring ouzel. The only way to obtain a good view of them is to sit quietly down near their haunts, on the chance of their approaching, as on the slightest attempt to follow them up they take alarm and fly off to a safe distance, usually alighting on a stone or small eminence, giving vent the while to an angry "chuck-chuck" resembling that of the blackbird. male during the nesting-time often sits on a tree or rock,

from which point of vantage he can take a survey, and guard against danger, and in the early mornings and close of evenings he sings a rather monotonous but clear-sounding song. It is the same note repeated over and over again, but from its wild character harmonises well with the surrounding scenery. During the day they sit very close among the heather or junipers, and, in common with the blackbird, they have a habit of skulking along the ground under cover, which is perplexing to any one wishing to observe their ways. As the birds advance in years, the white crescent on the breast becomes purer and wider, the females and the younger males having the white mingled with a few brownish feathers, which detract from their clean appearance. On the whole, I should say that ring ouzels are as numerous in Glenurquhart as it is possible for such birds to be, the ground being admirably suited to their wants. They disappear about October, but this year a pair were seen in January on Craig-na, most likely having remained all winter owing to the mildness of the weather.

HEDGE-SPARROW (*Accentor modularis*).

Found everywhere in localities suitable to its habits, but, being a quiet little bird, and fond of hopping in tangled thickets, or among heaps of dead branches, not so often seen as some others whose actual numbers are fewer.

ROBIN (*Erithacus rubecula*).

Frequents all the woods to a certain extent, but is most numerous in the fir wood, where the siskins and crossbills breed, and in the gardens at Balmacaan.

REDSTART (*Ruticilla phœnicurus*).

Redstarts are regular summer visitors, inhabiting the district from Craig-na to Abriachan, and along the road to Invermoriston. They are rather shy, but their presence is easily detected by the soft call, which, as already noticed, bears a resemblance to one of the notes of the chaffinch. If a person attempts to follow them through the wood they simply become mute, and glide swiftly out of harm's way,

but if he remains quite still, they will come close to hand. Along the Abriachan road they sit on the parapet wall or telegraph wire until any one approaches, when they make a sudden dive, like the wheatear, apparently to the ground, but on looking at the spot where they have disappeared no trace is found, as they have flitted silently a long way ahead. They fly out from the trees, and return again after the manner of the fly-catcher or the robin, and, from showing the red tail very prominently on these occasions, they are recognisable at a considerable distance. On Craig-na they may be seen flitting from tree to tree, almost invariably landing on the decayed stumpy branches which project from the stems of the pines; and in the solitary parts, where scarcely any other birds are met with, they may be heard whistling a very melodious though short song.

WHINCHAT (*Saxicola rubetra*).

Not by any means plentiful, but observed during summer at different points over the estate. I have noticed them more particularly on one farm, called Kerrowdown, where a little burn finds its way to join the Enerick through an open drain built of stonework, and although there are no whins anywhere near, they build either under cover of some bramble bushes alongside the drain or else among the loose stones.

WHEATEAR (*Saxicola œnanthe*).

Both the Lowland Scotch name of "Stanechacker," and the Gaelic name "Clacharan," are derived from the note of this bird, which resembles two stones knocked smartly against each other. Amongst the earliest migrants to arrive, they are always welcome as the forerunners of summer weather. In Glenurquhart they are most numerous on the slope from Gartallie to Cat-House, the dry-stone dykes which divide the little crofts being co ... ial to their habits. Like the whinchat, wher ... e to their nesting place, they in ... nd, finishing with a

BLACKCAP (*Sylvia atricapilla*).

George Muirhead, Esq., Paxton, procured a nest of the blackcap and the two old birds in June 1867 in the game covert near Drumbuie, and they are now in his collection.

SEDGE WARBLER (*Acrocephalus schœnobænus*).

In favourable years the marsh alongside of Urquhart Bay is tenanted by great numbers of these birds, a few stragglers also penetrating among the thick undergrowth of the game covert which runs inland to Drumnadrochit. Unlike many other small birds the sedge warbler sings at all hours of the day, although as a rule the mornings and evenings are the times when it is heard to best advantage. It is marvellous how such a small body can be capable of producing the volume of sound that it emits, but I fancy that in this respect it is excelled by the common wren, whose loud chattering would do credit to a bird six times its size.

GARDEN WARBLER (*Sylvia salicaria*).

Not very numerous.

WHITETHROAT (*Sylvia rufa*).

Distributed equally wherever tangled masses of shrubs and bushes are found.

WILLOW WARBLER (*Phylloscopus trochilus*).

Most numerous of all the warblers, and about the Abriachan woods and in all lower parts of the Glen they absolutely swarm after the nesting season is over, the greater proportion of course at that time being young birds.

WREN (*Troglodytes parvulus*).

Several of these birds are always visible more or less in the Divach Glen, in the fir plantation surrounding the parish church, and along the road running by the side of Loch Ness to Invermoriston. This Invermoriston road is part of the highway to Fort Augustus from Inverness, and, passing as it does through some of the richest woods of the whole district,

is a favourite resort of small birds during spring and summer. I have met with the wren in the wildest parts of Abriachan, higher up the mountain side than most small birds care to penetrate; and here, amidst extreme solitude and silence, its noisy chattering breaks on the ear with rather a startling effect.

GOLDCREST (*Regulus cristatus*).

Much oftener heard than seen, both from its small size and the circumstance of its plumage harmonising with the green of the spruce firs among which it is generally found. From January up to May they are very numerous about the same district as the crossbills, and are evidently fond of being in company with the cole tits and creepers. Like the robin and great tit, they are inquisitive, and often alight on the limed twigs of birdcatchers, more particularly, I have noticed, when the call bird happens to be a siskin. It is almost impossible to keep them alive in confinement.

WOOD PIGEON (*Columba palumbus*).

The winter of 1880-81 has considerably reduced the numbers of these birds, much to the delight of agriculturists, whose grain crops suffer considerably from their depredations. One with a pure white head was shot by a friend of mine last year.

CAPERCAILZIE (*Tetrao urogallus*).

Does not now exist in Glenurquhart, but at Guisachan, in Strathglass, only a few miles distant, some have been seen. An attempt was made to domesticate them in the woods at that place, but unsuccessfully.

PHEASANT (*Phasianus colchicus*).

Exceedingly numerous, as are also varieties of the same—namely, the Piebald and the Bohemian. A bird crossed between the common and the golden pheasant is also seen.

REEVE'S PHEASANT (*Phasianus Reevesii*).

This species was introduced into the district a few years ago, and has become tolerably plentiful. It is a great ornament to the woods, its beautifully marked plumage and long tail giving it a splendid appearance while in flight. It seems to be quite as hardy as the common pheasant in resisting winter storms.

BLACK GROUSE (*Tetrao tetrix*).

Numerous, especially about Abriachan woods.

RED GROUSE (*Lagopus Scoticus*).

Abounds on all the moors.

PTARMIGAN (*Lagopus mutus*).

A few inhabit the higher parts of Mealfourvonie.

PARTRIDGE (*Perdix cinerea*).

Plentiful in the cultivated parts.

WOODCOCK (*Scolopax rusticola*).

Breeds in the woods near Balmacaan, on a small patch of marshy ground.

SNIPE (*Scolopax gallinago*).

Shot occasionally, but does not seem to be very numerous.

LANDRAIL (*Crex pratensis*).

Common everywhere in the corn and hay fields. Before the grass is long enough to cover them they skulk about in ditches and among the thick undergrowth, occasionally uttering their harsh and disagreeable cry.

GOLDEN PLOVER (*Charadrius pluvialis*).

Breeds on the moor between Glenurquhart and Beauly.

LAPWING (*Vanellus cristatus*).

Also found in same neighbourhood, but not in such numbers as in the Lowlands.

HERON (*Ardea cinerea*).

Pays a visit to the shores of Urquhart Bay, and also to the river sides and hill lochs. It may only be fancy, but I cannot help thinking that this bird is becoming scarcer every year, as I used to see far more fourteen or fifteen years ago than I have done of late.

CURLEW (*Numenius arquata*).

Inhabits the same ground as the lapwing and plover, but does not appear to be very numerous.

COMMON SANDPIPER (*Totanus hypoleucos*).

On the banks of the Enerick, especially near its mouth, the "Sandy Laverock," as it is called in some districts, is a regular inhabitant in summer. Every one who knows the bird must be aware of its habit of flying backwards and forwards in a zig-zag line close to the surface of the water, all the time whistling in a peculiarly shrill manner. It does the same during the dark hours of night, and its cries beget an "eerie" feeling, and are sometimes very startling to nervous people. Its nest is frequently placed in most exposed situations, where it can scarcely escape detection.

Amidst the wildest and most unfrequented portion of a very uninviting and barren stretch of country lying midway between Glenurquhart and Beauly, are situated a number of tarns, known as the "Pike Lochs;" so called from the quantity of these fish that inhabit the waters. In their vicinity, and on a little island which rises out of one of them,

various birds come to breed in spring, among the species being the following:

REDSHANK (*Totanus calidris*).

WIDGEON (*Mareca penelope*).

BLACK-HEADED GULL (*Larus ridibundus*).

COMMON GULL (*Larus canus*).

In the marsh around Urquhart Bay a number of rare birds arrive during winter, but those are only occasional visitants, the ordinary species found at some period of the year being—

WATER HEN (*Gallinula chloropus*).

COOT (*Fulica atra*).

MALLARD (*Anas boschas*).

TEAL (*Anas crecca*).

TUFTED DUCK (*Fuligula cristata*).

A specimen of this bird was shot at Loch Latt in Abriachan.

RINGED DOTTEREL (*Charadrius hiaticula*).

G. Muirhead, Esq., Paxton, took a nest of this species in 1867 on the margin of Urquhart Bay.

A number of other birds not contained in this list have occurred from time to time in Glenurquhart, some of which only arrive at long intervals, others more frequently, their appearance greatly depending on the state of the weather—a severe storm at sea sometimes having the effect of driving in species which are rarely found so far inland. Among them might be mentioned different kinds of geese and ducks, gulls and divers; but to attempt a full catalogue, with the small amount of information that I possess, would be premature. I shall therefore take leave of the subject for the present, trusting to form a supplementary list at some future time of those birds that have been omitted from the present paper.

III. *On the Fructification of* Eusphenopteris tenella (*Brongn.*) *and* Sphenopteris microcarpa (*Lesq.*). By ROBERT KIDSTON. [Plate I.]

(Read 19th April 1882.)

1. *Eusphenopteris* (*Sphenopteris*) *tenella* (Brongn.). (Pl. I., figs. 1-6.)

Histoire des Végétaux fossiles, pl. 49, fig. 1 ; Illustrations of Fossil Plants, pl. xxxix.*

The barren and fertile fronds of this fern are dissimilar; and were it not for their occurring in unusually favourable circumstances, it would be impossible to ascertain that these two forms of fronds belong to the same species. I have found no fern associated with *Eusphenopteris tenella,* with the exception of a single specimen of *Sphenopteris delicatula* (Sternberg),† which appears, however, rather to be a small variety of *E. tenella* than a distinct species, as they are connected by intermediate forms. This circumstance appears to prove conclusively that the fructifying fronds can only belong to *E. tenella.*

All the fruiting fronds of this fern with which I have met were collected by myself at Furnace Bank, Sauchie, near Alloa, where it occurs very plentifully, but is limited to a single bed of arenaceous shale lying between the "Five-Foot Seam" and the Three-Foot Splint Coal.

Figs. 1 and 2 show two of the most common types of this plant as met with at Sauchie. Brongniart's figure represents only a small portion of a frond; a much better specimen is shown in the "Illustrations of Fossil Plants;" but it is there only designated "*Sphenopteris* sp."

Eusphenopteris tenella must have attained considerable size, as one of my specimens shows pinnæ 7 inches long, given off from an axis only the eighth of an inch thick. Of the barren fronds, some are lax and others much more compact; we have in the fertile fronds similar distinctions. This is shown in

* Edited by G. A. Lebour, 1877.

† "Essai d'un Exposé Geognostico-Botanique," Sternberg, pl. 26, fig. 5.

figs. 3 and 4. The capsules or urceolate indusiums are oval in form, and show a small depression at their apex, which probably indicates the position of an aperture (figs. 5 and 6). Their greatest length measures $\frac{1}{25}$ of an inch. They are arranged in two rows, one on each side of the rachis of the pinnule, the capsules being alternate, as shown in figs. 4 and 6; but they commonly appear as secund, the one row being bent over the other. This is well shown in fig. 3.

The different positions of the capsules are probably dependent upon their state of ripeness when fossilisation took place. From the fine state in which the specimens are preserved, the outline of the cells composing the capsules is distinctly shown.

The affinities of this fern to recent genera are somewhat obscure. The capsules in form resemble those of *Hymenostachys* (Hymenophyllaceæ); but in the fossils there is no discernible trace of a column, which forms a constant character in that genus. They agree, however, in the dimorphic condition of the fronds. I fear that at present we can only presume that this fern is most probably referable to the Hymenophyllaceæ. Both fertile and barren fronds are plentiful in the Coal Measures, Sauchie, near Alloa; and a fine barren specimen is exhibited in the Museum of the Glasgow University, from the "Roof of the Kiltongue Coal, Bailieston."

I have placed this fern in Schimper's *Eusphenopteris* in preference to Brongniart's generic name of *Sphenopteris*, as those individuals with cuneate segments form a very distinct group of the Sphenopteroids, and their removal from *Sphenopteris* helps to simplify that complex genus.*

In some recent works on vegetable palæontology attempts have been made to found a classification of ferns on the basis of their fructification; but so few fossil ferns having been obtained in this state has necessitated the introduction of two sets of characters in the classification of one group of plants: viz., those found in fruit are classified according to the structure and arrangement of that organ; but those whose fruit is still unknown, are classified, as formerly, from characters possessed by the barren fronds.

* Schimper und Zittel, "Handbuch der Palæontologie," p. 107.

If the system of classification according to fruit be adopted with *E. tenella*, I believe a new genus would be required for its reception; but for the foregoing reasons I prefer retaining it with the other Eusphenopteroids till more is known of their fruit. Even were there evidence for a complete classification founded on the fruit, it would prove of little value to the working palæontologist, who has, in the great majority of cases, to deal with barren specimens.

2. *Sphenopteris microcarpa* (Lesq.). (Pl. I., figs. 7-14.)

Atlas of Coal Flora of Pennsylvania, pl. xlvii., fig. 2; Coal Flora of Pennsylvania, p. 281.

About two years ago Mr J. Bennie handed to me for examination a small specimen of this fern, beautifully fruited, but which at the time I was unable to identify. Shortly after I saw a copy of the "Atlas to the Coal Flora of Pennsylvania and the United States," by Lesquereux, which was published in 1879. On plate xlvii., fig. 2, of this work a small Sphenopteroid is illustrated under the name of *Sph. microcarpa;* but from the figure given I could not definitely determine that the plant collected by Mr Bennie belonged to the same species, and at that time no description of it had appeared. This lack, however, was supplied in 1880, when the same author published the "Description of the Coal Flora of the Carboniferous Formation," etc. He gives here a very good description of the barren fronds; and in regard to the fertile it is stated that "each of the small obtuse teeth or indentations on the borders of the lobes has, at the top of one or two of the veinlets, small round elevated dots, which, when seen with a glass, appear like sori. I consider them as fructifications, comparable, by their position at least, to the fruit-dots of some *Davalliæ* of our time—*Leucostegia* for example."*

In the present specimen the fruit is exceptionally well preserved, showing the outline of the cells which form the walls of the sporangia (figs. 12, 13, and 14).

* *Loc. cit.*, p. 280.

The sporangia appear to be usually developed in groups of three, situated at the upper extremity of the veins, so that they become marginal in position (fig. 10). Sometimes, however, they are produced singly, as in fig. 11; but such cases are rare. I have not observed any sporangia situated in the sinuses; they are placed in the little lobes or teeth of the pinnules. The imperfect manner in which Lesquereux's specimen appears to be preserved may have led to this slight mistake in his description. The sporangia are oval in outline, and about $\frac{1}{78}$ of an inch wide in their greatest diameter. Most of them show a marginal border; and in one individual (fig. 14) the cells composing it appear to lie at an oblique angle to those forming the large central part; but whether this border is a true annulus or only a mechanically-produced simulation of that structure I am unable to decide.

Grand'Eury * describes the fruit of *Sphenopteris chærophylloides*, the sporangia of which appear to be very similar to those under consideration. In reference to his specimen, however, he states that the sporangia were not provided with an annulus. He seems inclined to regard *Sph. chærophylloides* as a transitional form between *Schizæa* and *Marattia*.

As regards *Sphenopteris microcarpa*, I think the character of the fruit points to affinities with the Osmundaceæ, and it is probably most closely related to the genus *Todea*. This species is widely distributed in the Coal Measures of Scotland.

I am indebted to Mr James Bennie for the pleasure of examining the fruited specimen, which was collected by him at Blairpoint, near Dysart, Fife. Mr Thomas Naismith has also kindly shown me the same plant from Mount Vernon, Lanarkshire; and I have met with it at Sauchie, near Alloa, Clackmannanshire, and near Dollar, on the borders of Perthshire.

None of the Carboniferous ferns, which from time to time have been obtained in fruit, appear to be referable to existing genera. Though in many cases they approach very closely,

* "Flore Carbonifère du département de la Loire." Paris, 1877.

yet they have hitherto always shown some character which has necessitated their being kept separate.*

EXPLANATION OF PLATE I.

Eusphenopteris tenella (Brong.).

Fig. 1. Portion of barren frond from Sauchie, near Alloa.
Fig. 2. Portion of larger form from same locality.
Fig. 3. Fertile frond, lax form, from same locality.
Fig. 4. Fertile frond, compact form, from same locality.
Fig. 5. Sporangia or capsules, magnified, showing the small apical aperture.
Fig. 6. The same, viewed more obliquely.

Sphenopteris microcarpa (Lesq.).

Fig. 7. Portion of barren frond, from near Dollar, collected by Mr A. E. Grant.
Fig. 8. Pinnule, enlarged.
Fig. 9. Portion of fertile frond, from near Dysart.
Fig. 10. Pinnule of fig. 9, enlarged, showing sporangia arranged in groups of three.
Fig. 11. Another pinnule, enlarged, more sparsely fruited.
Fig. 12. Two sporangia, magnified, showing slight indication of a marginal border.
Fig. 13. Sporangium, magnified, showing a slight obliquity of the arrangement of cells forming the marginal border.
Fig. 14. Another sporangium, magnified.

IV. *Notes on the Natural History of Madagascar.* By Rev. W. Deans Cowan.

(Read 19th April 1882.)

In October of 1874, we landed at Tamatáve, the principal seaport town on the east coast of Madagascar, and in that month, in 1881, we embarked at the same port for England; thus nearly eight years were spent in one of the most remarkable zoological districts on the globe.

A considerable portion of this time was spent in the province of Betsiléo, on the high central plateau; but at

* Stur, in his "Culm Flora," describes a fossil fern (*Todea Lipoldi*), which appears to be similar to *Sphenopteris bifida* (L & H.). As its fruit is unknown, his reason for placing it in the genus *Todea* seems simply to rest on the segmentation of the frond being somewhat of the same nature as that seen in such species as *Todea superba*.

different times, visits were made to other districts little known to Europeans, for the purpose of surveying and mapping out those districts. In this way much general knowledge was obtained of the people and natural history of the respective districts; in all, no fewer than twelve tribes were visited, some on the central plateau, others occupying the great forest, and the remainder along the eastern seaboard.

It is my purpose to place before you a general description of what we saw, in order to give you an idea of much that is peculiar in the zoology of Madagascar.

This island, which has up to this time excited but little interest, and that only amongst the few who were engaged in the work of Christian missions, is about 1000 miles in length, 250 miles in average breadth, situated a little over 200 miles from the nearest part of the African continent. It is a little larger than Great Britain and Ireland, and is the third largest island of the world. Situated for the most part within the Southern Tropics, it possesses a rare combination of tropical and temperate climes; this is not, however, so much owing to its geographical position, as to its physical configuration.

The centre of the island consists of a high plateau, nearly 5000 feet above sea-level. This plateau is a bare and open country of undulating pasture land, occupied by the provinces Imérina, Betsiléo, and the Bára land.

Surrounding this plateau is a broad belt of forest, which covers the hill-sides down to the lower lands which lie around the coast.

The climate of this central plateau is temperate, not unlike that of the south of Europe; that of the lowlands is tropical, and as may be expected, there is a wide range of the fauna and flora of the country. The eastern coast line is without much interest, as it is almost a straight line, without bay or inlet of any kind, a bare dreary line of sand, with the white breakers on the one side, and the green strip of filao (*Casuarinus madagascariensis*) trees on the other. There are no harbours, no roadsteads, a break or two in the coral reef being the only shelter for shipping. There is nothing beautiful, nothing picturesque.

Ascendi s, or passing through the very

narrow belt of filao (*Casuarinus madagascariensis*) trees, the usual fringe of the coast line, we enter upon a scene of great beauty. Before us it may be a wide plain, green and fertile, with here and there a clump of low trees, beyond a gently undulating country covered with traveller's tree, while in the distance, mountains rise in varied shapes and colours. This is as it appears from Tamatáve.

A little further south, the thickets along the shore become broader, but there are still open spaces covered with beautiful turf, reminding one of the lawns in our English parks.

The chain of lakes, winding here and there, widening out into miles of water, and again narrowing to a few yards, clusters of various trees that stud the park-like scene, the bright broad leaves of the traveller's tree, the pandanus, the lemon tree, and the rich luxuriance of orchids, complete a picture of the most exquisite and indescribable beauty. Such is the country which stretches for hundreds of miles along the coast.

The lakes, which are in some places separated only by a narrow belt from the shore, at others half a mile distant, are evidently of recent formation, and extend with but few interruptions along the greater part of the eastern coast. They receive from the interior great part of the smaller rivers, but are largely fed by the greater rivers, such as the Ivóndro, the Haróka, the Mangóro, the Mananzára, and several others of considerable importance, all of which have their source in the central plateau.

A few miles up from the lakes, the country is open and generally fertile, especially so near the banks of the rivers. For the first thirty-five miles or so, the country rises gradually to nearly 2000 feet above sea-level, and about this distance we have the limits of the traveller's tree and the eastern boundary of the great forest.

From this forest nearly all the fauna with which we are acquainted has been collected. The rich luxuriance of these primeval woods it is difficult to describe; the variety of the timber, the dense undergrowth, the huge creepers, the graceful tree-ferns, the beautiful orchids, the rich mosses, all must be seen to be understood. It is in the depths of these forests

that we meet the peculiar Aye-aye, and find most of the varieties of the Lemurs. Here, too, we meet with some of the rarest birds, such as the Euryceros, the Atelornis, and others, that delight in the lonely shades of the forest. Passing through the rough paths which cross the forest here and there, we often come upon exquisite pieces of scenery—an open glade, a picturesque clearing, a wood-cutters' village; but in the cold damp depths of the forest itself, the rank rotting leaves and timbers, the constant drip drip, is *gruesome* in the extreme,—one longs for light again and air.

Geology.

This vast island, with its low country, its undulating heights, its central plateau, is composed entirely of granite basalt, and other volcanic rocks. From the highest peak of Ankáratra down to the sea shore, there are but few traces of sedimentary rock. Inland from the lakes a few miles, there is a bed of dark clay, in which are many marine shells; thirty miles inland there is a stratum of flint—but these form the chief exceptions in such parts of the island as are well known to us. It was only when travelling towards the south-west, almost at the extreme western verge of the Bára land, that I came upon sedimentary rock in any quantity. The hills around Lake Itásy, and the numerous hot springs in different parts of the country, show that Madagascar was at one time the scene of much volcanic activity. Many of the hill-sides are composed of decaying granite, and to the south in Betsiléo there is evidence of currents having at one time denuded the eastern side of most of the hills.

Madagascar and the Mascarene islands are without doubt the remains of a former continent, which at one time occupied this part of the Indian Sea, but as to whether it was at any time connected with África or Southern India, is a question of extreme difficulty.

In relation to the formation seen, but not properly examined, in the western Bára, the Isálo hills appeared to belong to the sedimentary formation, and to have skirted what was at no distant date a lake of considerable size, the water markings in terraces being quite distinct along the eastern side. On the

eastern side of the central provinces we have the watershed of the whole island, and a few miles westward a comparatively straight line will give a very fair division of two districts, the eastern and western, possessing characteristic flora and fauna.

The People.

As far as I have been able to make out, the inhabitants belong to two very distinct races, which, for want of better terms, I call the Hóva and the Betsiléo. The Hóva occupy the province of Imérina, reaching out into one or two of the other provinces; the Betsiléo the remainder of the island, comprehending all the other tribes, such as the Tanála, the Ibára, the Sakalava, etc. The Hóvas are of Malayan descent, who have entered the island at a recent epoch, and have brought with them many customs and words from the Malayan Peninsula. But coming, as they probably did, as bands of marauders, with few women amongst them, they intermarried with the natives on the coast, and naturally adopted, they or their children, a great part of the language and customs of the aborigines. In course of time they were either driven inland by the other tribes, or they sought the higher lands which afforded a healthier climate and richer pasture for their herds of cattle. Here they gradually became consolidated into a rich and powerful tribe, and in course of time, being brought in contact with Europeans from whom they received arms and ammunition, they overcame all the other tribes, and are now the nominal rulers of the island, and recognised as such by European and other Governments. Of late years their advancement has been exceedingly rapid, and much attention is now being given to the education of the people. As a race they are active and energetic, kind and hospitable; anxious to adopt the manners and customs of Europeans. The few of them that have come to this country have, notwithstanding their great disadvantages, taken good places in our Universities. Their powers of organisation are considerable, as seen in their Government and its administration, the laws relating to educational and other matters, and in the large standing army and system of police.

The Betsiléo, on the other hand, although kind and hospitable, have not the intellectual vigour of the Hóva, having no idea of combination or government, divided into numerous tribes, which are often again sub-divided among petty chiefs, they are continually at variance with their neighbours, and few weeks or months pass without some disturbance or other.

This race is evidently of African origin, and bears considerable resemblance to those on the opposite coast of the mainland. Unlike the Hóva, they are averse to religion or any systematic education. They are darker in complexion, more robust, and altogether have a finer physique than the Hóva race; they are franker, more manly, less deceitful, and more honest than the Hóva.

Although nominally regarded subject to the Hóva, they for the most part refuse to allow the Hóva to have any practical authority over them, and are only kept in check by detachments of Hóva soldiers scattered through the country. The Hóvas are skilful in the manufacture of silver and iron work, imitating for the most part European designs. There is no evidence of native art in the shape of carvings, or woven designs, except such as has been borrowed recently from the ruder Betsiléo. The Betsiléo, on the other hand, display carvings on all their tombs and houses of any importance, and their mats and native cloth are often figured with elaborate and chaste designs.

MAMMALIA.

Of the Mammalia, there are twenty-seven genera, containing sixty-five species, found in the island. Of these there are only six genera found in the African continent, and these with one exception are widely distributed over the world, being almost cosmopolite.

Hence the relations of the mammals of Madagascar to those of Africa are not much closer than they are with other zoological divisions of the earth. Strange to say we find none of the larger mammals which are so numerous and characteristic of Africa, on the island. Of the Hippopotami there was evidently one species existing in Madagascar within the past 100 or 150 years. The traditions of the people tell

of a large river cow that once existed amongst them, and when we exposed the skulls and skeletons of the animal at Sira-bé in northern Betsiléo, they were at once recognised by the elderly amongst the people as being the remains of that animal. At this place five or six skulls and the remains of the skeletons were found, all within an area of a few square yards, and close to the surface of the ground. One genus of the African mammals is found only in India and adjacent islands. The problem as to the geographical position of Madagascar, as to whether it is part of a former continent which we might term an Indo-African continent, or as to whether it was at no time in connection with Africa, is one difficult to solve as far as the mammals are concerned. It is easy to imagine a time, when a wide ocean rolled over Sahara and Arabia, separating two continents, a north and south, each distinct in their fauna—the north, rich in the higher forms of life, such as the carnivora,—the south, with its lemurs and its large, almost wingless birds, and of a subsequent period when the eastern part of the southern continent is gradually sinking, while the north, such as Sahara and Arabia, are rising from the waves, till at last there remains only Madagascar and the Mascarene Islands retaining their old forms of life, and the higher animals are pushing southward through the Sahara into our now central and southern Africa. But such a theory would scarcely explain the wide differences that now exist between Africa and Madagascar.

We are met in Madagascar by an extraordinary fauna, having resemblances to that of the African, the Malayan, and the South American, but with a large number of peculiar types. Of the lemurs, the most characteristic family of Madagascar, we have six genera, represented by thirty-four species, not one of which exists in Africa, besides a large number of peculiar animals, such as the aye-aye and the cryptoprocta. Now, of these many Malagasy types we might expect to find some at least, in South and South-Central Africa, if there had been, as has been suggested, such an intimate connection in times past. Few animals are better adapted for self-preservation than the lemurs, their arboreal habits and their

active movements being sufficient to protect them from the larger feline animals. The cryptoprocta, on the other hand, the largest of the carnivora in Madagascar, living as it does in the denser forest, or on the rocky mountain sides, is well able to defend itself, and maintain its own amongst members of the same family.

Of the carnivora we have five genera and nine species in Madagascar, not one of which is found in Africa or any other place. Africa, rich in the same order, has no less than nine families, many of which are widely distributed, but have no representative in Madagascar. Questions such as these arise: How came the extermination of the different genera of lemurs in Africa, with the exception of the three genera which are found at Old Calabar and Sierra Leone? How came the cryptoprocta into Madagascar? and how is it that there is such a wide difference in the carnivora?

Lemurs.

This family of animals, with one or two exceptions, is confined to the forest, and subsists upon leaves, fruit, and the smaller insects, such as spiders, found there. Lemurs are not, as is often supposed, purely nocturnal. *Microrhynchus laniger* is the only one that appears to belong to this class. They are most active in the early and latter part of the day. In the early morning towards sunrise they generally leave the recesses of the forest for the outskirts and bask in the early sunlight, generally sitting with their hind legs stretched along a branch, and their fore arms so placed as to fully expose their chest and under part of their body to the heat of the rising sun. They are much more active amongst the trees than the monkey family, and pass with great rapidity from one part of the forest to another. *Cheirogaleus Smithii*, the smallest of the tribe, builds a small nest for itself, not unlike that of the squirrel but much less, in the lower bushes of the forest. *Microrhynchus laniger* is mostly to be found in hollow trees like the aye-aye, the others content themselves on the bare branches. *Lemur catta*, and a pure white lemur closely allied to it, are found on bare mountain rocks, where

they live upon spiders and leaves, and such fruit as they can obtain.

Many of the lemurs are very local. *Propithecus holomelas* has hitherto only been found in a very small part of a forest in Betsiléo.

BIRDS.

The birds of Madagascar are almost as peculiar as the Mammals. We have no less than 35 genera, represented by 57 species, which are found only in the island.

Leaving out doubtful affinities, such as *Oxylabes, Mystacornis, Cyanolanius,* and *Calicalicus,* we have still about 30 genera, of which there is no doubt. These for the most part belong to families which are found in Africa, but of such families as are purely African, we have not a single representative in Madagascar. Of the genera that are common to Africa and Madagascar, 8 are exclusively so, but 22 extend to India and its islands, 13 are found in the Australian Continent, 15 wander to Northern Europe and Asia, 11 are common all over the world, and 2, strange to say, are found only in Palestine.

In travelling through the forest of Madagascar, nothing strikes one more than what appears to be the absence of bird life. Now and again one hears the cry of the *Centropus tolou,* mostly on the outskirts of the forest. One passes the brilliant *Coua cærulea,* making its way quietly through the forest; but that is the most that is generally seen or heard of the birds in the great forest. True, if we were to penetrate into the denser forest, we might come upon the *Atelornis pittoides* or *Crossleyi,* the *Euryceros Prevosti,* the velvety *Philepitta jala,* or such birds as love the recesses and lonely shades of these silent woods. Suddenly, and often unexpectedly, the trees overhead become filled with crowds of birds, chattering in many a different note—that is what may be called a drive of birds. Hundreds, sometimes thousands, of them have congregated for feeding purposes, and are now passing through the forest, clearing the insects from trees and shrubs. Conspicuous amongst them for size and noise is the *Dicrurus*

forficatus, *Tylas Eduardi*, and *Campephaga cana;* of the smaller birds, there is the *Zosterops madagascariensis*, the two *Bernieria*, the *Leptopterus viridis*, and the chattering *Newtonia*, with many others. It is by following such drives that the natives are able to obtain so many birds with their blow-pipes. The birds that frequent the more open parts of the country are the *Pratincola sybilla*, *Cisticola madagascariensis*, *Eurystomus madagascariensis*, *Hypsipetes ourovang*. The peculiar little *Dromocercus* wanders quietly amongst the grass, beside the streams in the glades of the forest, and is never seen perching, except in some natural history plates! The *Leptosomus discolor*, a rather remarkable bird, delights in the outlying forest, where his peculiar cry of dre-dreo is frequently heard.

The *Cuculus Rochii* begins his spring song in October, or early part of November, and farms out his young there, as in all other countries. His note changes considerably just before he takes his departure, whether to the low countries or across the sea, I cannot say. The egg is very unlike that of any other cuckoo, and varies to some extent in the marking. The nests it most frequents are those of the *Pratincola sybilla* and the *Cisticola madagascariensis*, although it is often found in the nests of *Cossypha Sharpei* and *Copsychus pica*. The nesting season in Madagascar extends from November to February or March, the common *Foudia* being amongst the last of the nest builders.

Mesites has only hitherto been found in the north-east of Madagascar. The only specimens of this remarkable bird which have come to this country are in the possession of Canon Tristram of Durham. The *Falculia palliata*, *Upupa marginata*, *Ninox superciliaris*, *Ploceus sakalava*, *Foudia erythrocephala*, and a considerable number of the *Couas*, are only found on the western division of the island. *Coua cœrulea* is well distributed through the whole of the country, while *Coua Reynaudii* and some of the others are extremely local. *Scopus umbretta* is to be seen in nearly every rice field, and their monster nests of sticks and other refuse are conspicuous on many a stone and tree. The guinea fowl exists in thousands over different parts of Western Madagascar.

The *Neodrepanis* has only hitherto been found in a small part of the forest to the east of the capital.

SNAKES.

Snakes of several genera are common, but all of them innocuous. Many stories are prevalent amongst the natives as to the dreadful powers of some of these animals, and these have been readily believed by European residents; but I have examined every species, even those most dreaded, and have found them perfectly harmless.

The *Pythonidia,* represented by a peculiar genus, *Sanzinia,* is common both in the forests and in the highlands, and about these the natives have much superstitious feeling. The female of one species is supposed to have emerged from the tomb of a former king. As this animal is beautifully marked, not unlike the designs on the native mats, the people say, that they received their first ideas of those patterns from this animal. The male of this same species, wrongly considered by the natives and Europeans resident in the island to be a different reptile altogether, has even more superstition attached to it than the female. By a most disgusting process, they pretend to derive it from the dead bodies of their chiefs, and whenever one of these animals is found, it is captured with much ceremony, rolled in silk cloths, and fed on the richest of milk, on the supposition that it contains the spirit of the chief from which it has been derived. The species lives upon rats and such animals, and is exceedingly fond of young Indian corn. At one time I kept several of the females of this species, called by the natives *Dona,* and one of them presented me with seven young ones, which, as they disappeared, were afterwards the cause of some amusement and excitement in our compound. The last we saw of them, was when one of the ladies, about to place her child in the crib, saw what she supposed to be a slipper, but which to her horror turned out to be one of these young pythons, now well grown. There are large numbers of lizards, more especially on the upper plateau, but of these I am not at this time able to say much.

Insects.

Much has been said as to some spiders which have again and again been declared poisonous. Of these I have collected hundreds, and my Betsiléo assistants took them up fearlessly in their hands and laughed at the idea of their being dangerous. In the forest and outlying patches of wood, spiders are very numerous, and often cover the branches with thick networks. The people in the forest spin these webs, and make them into a kind of rough cloth. Although I have large collections of the *Lepidoptera* and *Coleoptera,* I am not fully acquainted with them. The diurnal moth *Urania* now shown is a most interesting insect, as all the other species of this genus inhabit tropical America and the West Indian Islands. It is usually to be found on the western outskirts of the great forest. In some years it appears in great numbers, and proceeds inland, when thousands of them may be caught in any garden where "bebas" trees are in blossom. The *Papilio antenor,* at one time a valuable insect, is only found in the western districts, and there in considerable numbers. The native silk-worm is largely cultivated by the people in the southern part of the Betsiléo province. The cocoon of this insect is covered with short black hairs, which are generally removed by rubbing them on the ground, or covering them with cow-dung. The cocoon is then slit up, and the chrysalis taken out for food, inverted and softened in hot water, drawn out and spun into a rough coarse thread. The caterpillars and cocoons are largely sold in the local markets. The moth, male and female, you have before you.

In *Coleoptera* Madagascar is exceedingly rich, more especially in the *Cetonidæ,* which are found in great numbers all over the island, especially in the months of December and January. The grub of one beetle, the cockchafer, is eagerly sought for by the natives in the damp ground at the commencement of their spring, and is esteemed by them a great delicacy. Of the locusts there is a considerable variety, no less than forty or fifty species being collected by me within a few yards of my own house. The migrations of one species of this

insect are very irregular; for years they may never appear, and then suddenly they come in clouds, darkening the air, or filling the valleys below like a white vapour. As they generally settle on the ground before sunset for feeding purposes, the natives gather them in basketsful, and for days and weeks afterwards, they form regular articles of diet.

FLORA.

Our knowledge of the flora of Madagascar is as yet rather defective, the collections which have come to this country having been made in a very limited area. The family that seems most common is the *Rubiaceæ*, and hence all plants belonging to this family flourish well. Coffee wherever planted, whether on the high plateau, on the fertile sides of the great forest hills, or on the yet lower lands, is very productive. In the western district we have a very distinct flora from that of the east, but at this time it is little known. The natives cultivate sugar-cane over the greater part of the island, for the purpose of making native rum. The soil, like that of Mauritius, seems especially suited for this plant, and the canes are usually rich and productive. The central plateau produces almost any kind of European plant, the valleys being usually devoted to rich culture, while wheat and potatoes grow well on the plains. Tobacco is grown and largely used by the natives, but the plants are best on the eastern edge of the plateau and clearing of the forest. Of the ferns, and some other cryptogams, to which I have given some attention, we know about 270 species, of which there are 70 peculiar to the island, 109 are common to Madagascar, Mauritius, and Bourbon, 28 of them are found in Bourbon, and 4 in Mauritius, while 59 are found elsewhere. As far as they can be traced, as a whole they have much nearer relation to the same plants in Africa, than to any other part of the world.

CLIMATE.

The climate of the country, as has been already stated, is varied, but in no part can it be called unhealthy, as is understood of western and central Africa. In the interior, where I was resident for seven years, a register was taken for several years in succession, and from notes of these registers, in my possession, the following is obtained:—January, the highest temperature registered in the shade at midday was 84° Fahr., and the lowest taken at 6 in the morning was 62° Fahr.; February the 5th, it stood at 80° Fahr. at 12 o'clock, and at 6 in the morning of the 3d, it was registering 64° Fahr.; on three days in March, 25th, 12th, and 16th, it stood at 80° Fahr., and on the morning of the 14th and 23d, shews 60° Fahr. In April we have 80° at midday, and 59° in the morning. In May we had 79½° and 58° Fahr.; in June, 74° and 54°; in July, 72° and 44°; in August, 70° and 51°; in September, 68° and 52°; in November, it had risen again to 81° and 60°; and in December, to 84°; thus, our highest temperature in the shade was during the months of December and January, and our lowest in July and August, and the total variation only 14° in these months. To the east, and especially to the west coast, it is very much hotter, but I am not aware of any register having been taken of the temperature.

LAND.

The riches and wealth of this country, the soil, and the minerals, have never been understood by Europeans, and hence up to this time it lies in all its primeval richness, offering a grand opportunity for commercial enterprise.

DISTRIBUTION OF ANIMALS IN SOUTH CENTRAL MADAGASCAR.

There are three well-marked geographical districts in South Central Madagascar, to which the Nos. 1, 2, 3, are given. No. 1 comprises the forest land that lies between the Betsiléo and Tanála. It covers the eastern side of the mountains along the edge of the central plateau. The forest is thick and dense, about fifteen or twenty miles in width. No. 2 is that part of the central plateau which lies between the western edge of the forest and 46° 55′ east. Country hilly, with very few patches of forest, the principal of these being at Ankafana and Nandehizana. Hills covered with grass; valleys with cultivated rice fields. In this district are the head waters of many important rivers. No. 3 is west of 46° 55′ east, and lies for the most part in the Bára country. The district is sheltered by the hills to the east, and is generally unhealthy. 46° 55′ east is a very marked divisional line, both in the Flora and Fauna.

[O, common. –, found at certain seasons. I, seen once during eight years. F, seen occasionally. A, Forest of Ankafana. N, Forest of Nandehizana.]

MAMMALIA.	*No.* 1.	*No.* 2.	*No.* 3.
Cryptoprocta ferox,	O	F in A and N	F
Viverricula malaccensis,	O	F	...
Eupleres goudoti,	O	I	...
Hemicentetes nigriceps,	O	O	O
,, madagascariensis,	O	O	O
Centetes ecaudatus,	O	O	O
Ericulus setosus,	O	O	O
Nesomys rufus,	...	O in A	...
Miniopteris scotinus,	...	...	...
Mycrogale longicaudi,	...	O in A	...
,, cowani,	..	O in A	...
Galidia elegans,	O	O in A and N	...
Propithecus holomelas,	...	O only in N	...
,, edwardii,	O	O in A and N	...
Cheirogaleus smithii,	O	O in A	...
Microrhynchus laniger,	O	O	...
Lemur catta,	...	...	O
,, rufifrons,	O	O in A and N	...
Varecia varia,	O	O in A and N	...
Lepilemur mustelinus,	O	O in A	...

BIRDS.	*No.* 1.	*No.* 2.	*No.* 3.
Buteo brachypterus (*Pelz.*), . .	O	O	O
Falco minor (*Bp.*), ...	O	O	O
,, Eleanoræ (*Gene.*), . . .	F	F	F
,, concolor (*Temm.*), . . .	F	F	F
Tinnunculus Newtonii (*Gurn.*), .	O	O	O
Baza madagascariensis (*Sm.*), . .	O	F	O
Milvus ægyptius (*Gm.*), . . .	O	O	O
Astur Hensti (*Schleg.*), . . .	...	F	...
Scelospizia Franciscæ (*Sm.*), . .	F	F in A and N	F
Circus macroscelus (*Newton*), . .	F	...	F
Polyboroides radiatus (*Scop.*), . .	...	F	F
Scops rutilus (*Pucher*), . . .	O	O in A	...
Otus capensis (*Smith*), . . .	F	F	F
Ninox superciliaris (*Vieill.*), . .	...	O in west only.	O
Strix flammea (*L.*), ...	O	O	O
Caprimulgus madagascariensis (*Sg.*),	O	O	O
,, enarratus (*G. R. Gray*),	...	F in west.	O
Collocalia francisca (*Gm.*), . .	O	O	O
Cotyle Cowani (*Sharp*), . . .	...	O in A	...
Phedina madagascariensis (*Hartl.*), .	—	—	—
Eurystomus madagascariensis (*L.*), .	F —	O – in A	O —
Atelornis pittoides (*Lafr.*), . .	O	O in A	...
,, Crossleyi (*Sh.*), . . .	O	...	..
Corythornis cristata (*L.*), . . .	O	O	O
Ispidina madagascariensis (*Briss.*), .	O	...	...
Merops superciliosus (*L.*), . .	O	I	O
Upupa marginata (*Pet.*), . . .	...	...	O
Falculia palliata (*Is. Geof. St Hil.*), .	...	...	O
Nectarinia souimanga (*Gm.*), . .	O	O	O
,, angladiana (*Sh.*), . .	O	O	...
Zosterops madagascariensis (*L.*), .	O	O	O
Erœssa tenella (*Hartl.*), . . .	O	O	O
Ellisia typica (*Hartl.*), . . .	O	O	O
,, filicum (*Schleg.*), . . .	O	O	...
,, lantzii (*Grand.*), . . .	O	...	...
Calamoherpe Newtoni (*Hartl.*), .	O	O	O
Cisticola madagascariensis (*Hartl.*), .	...	O	O
Dromocercus brunneus (*Sharp*), .	F	O in A	...
Pratincola sybilla (*L.*), . . .	O	O	O
Motacilla flaviventris (*J. Verr.*), .	O	O	O
Cossypha Sharpei (*Gr.*), . . .	O	O in A and N	...
Copsychus pica (*Natt.*), . . .	O	O in A and N	...
Hypsipetes ourovang (*Gm.*), . .	O	O	O
Tylas Eduardi (*Hartl.*), . . .	O	O in A	...
Bernieria madagascariensis (*Gm.*), .	O	O in A	...
,, zosterops (*Sh.*), . . .	O	O in A	...
Dicrurus forticatus (*L.*), . . .	O	O in A and N	O
Leptopterus viridis (*Gm.*), . .	O	F in A and N	O
Cyanolanius bicolor (*L.*), . . .	O	...	...
Philepitta jala (*Bodd.*), . . .	O	O in A N	...
Oxylabes madagascariensis (*Briss.*), .	...	O in A N	...
Mystacornis Crossleyi (*Sh.*), . .	...	O in A N	...
Crossleyia xanthophrys (*Sh.*), . .	...	O in A N	...
Newtonia brunneicauda (*Newt.*), .	O	O in A	O
Terpsiphone mutata (*L.*), . . .	O	O	O
Campephaga cana (*Gm.*), . . .	O	O	O
Calicalicus madagascariensis (*L.*), .	O	O in A N	...
Vanga curvirostris (*Gm.*), . .	O	F in A	...

BIRDS—*continued.*	*No. 1.*	*No. 2.*	*No. 3.*
Corvus scapulatus (*Daud.*), . .	O	O	O
Hartlaubia madagascariensis (*L.*), .	O	F in A	...
Hyphantornis pensilis (*Gm.*), . .	O	O in A N	...
Foudia madagascariensis (*L.*), . .	O	O	O
Spermestes nana (*Pucher*), . .	O	O	O
Alauda hova (*Hartl.*), . . .	F	O	O
Coracopsis nigra (*L.*), . . .	O	O	O
,, vaza (*Shaw*), . . .	O	O	O
Psittacula cana (*Gm.*), . . .	O	...	O
Coua Reynaudii (*Puch.*), . . .	O	O	...
,, pyrrhopygia (*Grand.*), . .	...	. .	O
,, cærulea (*L.*), ...	O	O	O
Centropus tolou (*Gm.*), . . .	O	O	O
Cuculus Rochii (*Hartl.*), . . .	O	O	O
Leptosomus discolor (*Herm.*), . .	F –	O – in A	F –
Alectrœnas madagascariensis (*L.*), .	O	F in A	...
Columba Polleni (*Schleg.*), . .	O	...	O
Turtur picturatus (*Temm.*), . .	O	O in A	O
Œna capensis (*L.*), ...	...	I	O
Numida mitrata (*Pall.*), . . .	O	F	O
Margaroperdix striata (*Gm.*), . .	O	F in A	O
Coturnix communis (*Bonnat*), . .	O	O	O
Turnix nigricollis (*Gm.*), . . .	O	O	O
Glareola ocularis (*J. Verr.*), . .	...	...	O
Ardea purpurea (*L.*), . . .	O	O	O
,, gularis (*Bosk.*), . . .	O	O	O
,, comata (*Pall.*), . . .	...	F	O
,, bubulcus (*Sav.*), . . .	O	O	O
Scopus umbretta (*Gm.*), . . .	O	O	O
Platalea tenuirostris (*Temm.*), . .	...	F –	F –
Tantalus ibis ? (*L.*), ...	...	...	I
Lophotibis cristata (*Gm.*), . .	O	...	...
Actitis hypoleucus (*L.*), . . .	...	O	O
Gallinago Bernieri (*Pucher*), . .	O	F –	...
Rhynchæa capensis (*L.*), . . .	O	O	...
Rallus gularis (*Cüv.*), . . .	O	O	O
Porzana pygmæa (*Naum.*), . .	O	O	O
Corethrura insularis (*Sharpe*), . .	O	...	...
Porphyrio smaragnotus (*Temm.*), .	O	...	...
Canirallus griseifrons (*G. R. Gray*), .	...	O	O
Sarcidiornis africana (*Eyt.*), . .	F –	F –	O
Nettapus auritus (*Bodd.*), . .	...	...	O
Dendrocygna viduata (*L.*), . .	O	O	O
,, major (*Jerd.*), . .	O	...	...
Anas Melleri (*Sclat.*), . . .	O	O	O
Podiceps minor (*L.*), . . .	O	O	O
Plotus melanogaster (*Gm.*), . .	O	O	O
Halieus africanus (*Gm.*), . . .	O	O	O

Of the twenty Mammals, only six occur in division 3, and of these *Lemur catta* is peculiar to it. The open country is not suited for the Lemur family, and the one that is common there has its habitat on the bare rocky mountain sides. It is possible that further research may lead

to the discovery of many of the other Mammals as visitors.

Of the 115 birds, the greater number are found in No. 2, and 74 in No. 3; of which 8 are rare and 4 are peculiar to it.

V. *On the Gnawing of Water and Gas Pipes by Rats and Mice.* By A. Galletly, Museum of Science and Art, Edinburgh.

(Read 18th January 1882.)

The incisor teeth of the rodentia are sharp, strong, and chisel-like. They continue to grow during life, and through the dentine, of which the body of the tooth is composed, wearing away faster than the thin, hard, anterior layer of enamel, the latter forms a sharp cutting edge, strengthened by a bevelled backing of dentine. The condyles of the lower jaw are antero-posteriorly elongated, so as to allow of a considerable amount of back and forward motion on the cranium, or *vice versâ,* if the latter be fixed, of the cranium upon the lower jaw. By this peculiarity in the anatomy of its head, a rodent can at will bring the upper incisors in front of the lower, or the lower in front of the upper, and thus, by an equal wearing away of both pairs of incisors, their chisel shape is maintained. If a rat or a rabbit, for example, breaks an incisor tooth, or if through any other cause this equal wearing of any of the front teeth is interfered with, then a curious result follows. The tooth which has no longer an opposite one to rub against grows long and circular, and eventually prevents the animal from taking food.

With these few words of explanation about the nature of its teeth, I shall now take up the rat's doings in the way of destroying water-pipes. According to some authorities, the rat in ancient Egypt symbolised "utter destruction," and also "judgment," because it always chooses the best bread for its repast. Perhaps these animals likewise choose the best water for their drink, and this may sometimes be the reason why, as some persons assert, they gnaw holes into

lead pipes used for conveying clean water, under circumstances where they had more ready access to water of a less pure kind. The first piece of a rat-gnawed pipe which I ever saw was given to the Edinburgh Industrial Museum, in the year 1855, by Messrs Hay & Addis, then in extensive business as plumbers in Edinburgh, along with some other pieces of lead pipe corroded into holes by the chemical action of something in the soil by which they had been covered. They had previously kept the gnawed pipe for six years as a curiosity in their shop. Noticing with respect to these, and to some other similar examples, that the corroded and the bitten pipes bore, at a superficial glance, some resemblance to each other, it struck me that rats might more frequently be the cause of leakage in water-pipes than is commonly suspected. It is easy to make out the difference if the marks of the rats' teeth are well preserved, but not quite so easy if the gnawed surface has from any cause become partially worn away. Since then I have occasionally asked plumbers and other persons likely to be informed on the subject, if they ever met with examples of lead piping into which holes had been bitten by rats; and from their answers I would infer that, although not a rare, neither is it a thing of very frequent, occurrence about Edinburgh. It appears, however, to be far more common about Glasgow, Dundee, and some other places. Only last week a curious rat case was tried in the Dundee Sheriff Court. Rats had on six different occasions gnawed a water-pipe in a hotel, and flooded a barber's shop immediately below it. Counsel for the pursuer argued that rats, like exceptional snow-storms, must be provided against by house proprietors, and the Sheriff gave judgment for £6 for damage and loss of business, with £1 of expenses.

It is curious that in an essay on Rats, extending to nearly a hundred pages, by the late Mr Frank Buckland, and published in 1862, he takes no notice of these animals exercising their teeth on metal pipes, although both he and some other writers on natural history, who likewise omit all mention of this fact, give many instances of their gnawing ivory, hard-wood, nuts, leather, and other substances. Indeed, I do not remember having seen much in print about the gnawing of

metal pipes till in 1879 a correspondence on the subject of "Intelligence in Brutes" took place in the columns of *Nature*, when the matter was referred to in the letters of six or seven different writers. In these communications a number of instances—none of them, however, exceptionally interesting—are given, and several opinions expressed respecting the purpose for which the rats gnaw the pipes. Some think it is done simply to get at the water; others, that it is because the pipes are in the way of their tunnelling operations; others, again, that it is merely for the love of gnawing. One writer considers the rats find out that pipes contain water through their cutting them, in the first instance, as obstructions. Mr Darwin thinks they hear the water trickling. In Edinburgh and some other towns they must often hear the water rushing. It may sometimes be the case that a very slight crack or "sweating" of a pipe—yielding at intervals only a mere drop of water—tempts rats to gnaw a hole in the lead in order to get a proper draught. A correspondent of *Nature* relates an instance of rats gnawing the bullets in Martini-Henry rifle cartridges, in order, no doubt, to get at the grease.

The most extraordinary specimen of a gnawed pipe which I have seen, is one which was given to Professor Archer in September 1877 by Mr J. J. M'Andrew of Lukesland, Ivy Bridge, Devon. It was part of a vertical pipe for pumping water from the fresh-water tank in the bottom of a ship to the deck. The rats, in their desperation to get at the water, have bitten it away by degrees till they have made a hole 13 inches in length by about 1 inch of average breadth. In other words, they have completely removed with their teeth 13 square inches of lead, $\frac{3}{16}$ of an inch thick. Here is another example of a gnawed waste-pipe, for which I am indebted to Dr Grierson of Thornhill. It has two holes in it, the larger of which measures about 8 square inches, but in this case the lead is barely $\frac{1}{8}$ of an inch thick. A very similar example has been sent to me by Mr Nucator, plumber, Dundee, who has also told me of one or two cases where great annoyance and trouble have been caused through waste-pipes from water-closets having been gnawed by rats

in situations where the holes thus made had escaped detection for months.

Mr Buckland says that the want of water will kill rats in a very few hours. He gives an instance of a rat dying for want of water, although it had wet bread to eat; at least that was the opinion of a rat-catcher whom he consulted, and with whom he plainly concurred. This, if true—and there seems no reason to doubt it—would explain how, even when water is otherwise sparingly at hand, the thirsty animals may cut through pipes to get a copious draught. It might even explain the case, also quoted by Mr Buckland, of rats gnawing down a breach through the entire depth of a cask containing sweet wine, and drinking its contents. He thinks they must have got very tipsy in the act of quenching their thirst, as for two whole nights, during which the wine is supposed to have lasted, strange noises were heard, to the great alarm of the old lady in whose house the cask was stored. In *Nature*, for May 1, 1879, the information is given, on the authority of a distiller in Cincinnati, that rats drink spirits which have been spilt on the ground or left in open vessels, and in this way often become so tipsy that they cannot run, and are easily caught.

Dr Lauder Lindsay, Dr Wynter, and other writers, also refer to the fact that rats get intoxicated with various drinks. Thinking that if this were at all a common thing they would likely be fond of sweet ale, I have made inquiries on the subject at one or two of our Edinburgh breweries, and have learned that rats are frequently seen stupefied with the beer they drink. They not only drink spilt beer, but get up on the tops of casks, and regale themselves at the bungholes. Some brewers think that many rats become "seasoned," and that it is only the novices that get drunk. Dr Wynter states that lead pipes leading from beer barrels have been found gnawed by thirsty rats.

I turn now to a rather more serious matter—namely, the cutting of gas-pipes by both rats and mice. A rat hole in a Dutch dyke may produce alarming results, but in this country an escape of gas is generally a thing of more danger than a rush of water from any pipe a rodent could gnaw.

Since mice are greatly more common in houses than rats, and both gnaw metal tubing, it follows that the smaller and usually less dreaded species is likely to be, of the two, by far the more frequent cause of injury to gas-pipes. Few of us ever consider the risk we are exposed to by the doings of these insignificant looking creatures. We all know that they gnaw books, title-deeds, and the like, but comparatively few of us are aware how easily they can prepare an explosive mixture by which at any moment we may be blown up. Very likely many of the unaccountable gas explosions we hear of are due to rats or mice.

Internal gas-pipes are usually made either of tin or of what is called "composition metal," which is an alloy containing very little of anything but lead. Tin pipe is decidedly the harder and better of the two kinds, and was long in use before the demand for cheap gasfittings caused composition pipe to be made. Rats can easily cut both kinds with their teeth, but mice apparently can only gnaw tin pipe with considerable trouble, as they seldom try it, but with the softer gas tubing they have no difficulty. As an example of what a single mouse can do in the way of gnawing, I may state, that, having unconsciously locked one inside a cabinet with close-fitting doors, the poor animal, in its struggle to escape, had splayed away with its teeth the square edge of a hard mahogany shelf to the extent of fully an eighth of an inch for about two feet of its length.

I have here three pieces of composition gas-pipe, removed very recently from a large establishment on the North Bridge, Edinburgh, by Messrs Stewart & Rae, Register Street, whose manager, Mr Thorburn, has kindly preserved them for me. This was the second time that mice-gnawed pipes were taken away from under the floor of the dining-hall on the same premises. The specimens illustrate very well the usual appearance of pipes so injured, and the position they were taken from was one where mice commonly attack gas tubing in order to make a passage for themselves. The pipe from which these gnawed pieces were cut was laid across the joists in the narrow space between the flooring boards and the "deafening." It was passed through a notch in each joist, and it was at these

points that the mice intended to cut their way when, no doubt much to their surprise, an escape of gas suddenly checked their chiselling operations. Sometimes, however, they gnaw the pipe midway between two joists when it nearly fills the space between the boards of the floor and the upper surface of the "deafening." Instances also occur of their biting holes in vertical tubing when they want to get up or down. It will be easily understood that the holes they make are never large, as they must beat a retreat whenever the gas leaks. Mice, and apparently rats also, usually blacken a gas-pipe to the extent of a few inches before they begin to gnaw it. This black stain, when soaked in distilled water, filtered, and tested with nitrate of silver, shows abundance of chlorides, indicating dried urine. Probably the simplest way to prevent these animals from experimenting with their teeth on gas-pipes would be to see that they have "head-room" to race about under the floor, and to make notches in the joists for them as well as for the pipes, because, like wise engineers, they never tunnel without first making an accurate survey of the ground. Tin pipes, are, however, pretty nearly safe from their attacks; iron ones, we know, completely baffle them.

VI. *The Nesting of the Eider Duck.* By Professor Duns.

(Read 21st December 1881.)

Abstract.

Three nests of the Eider Duck (*Somateria mollissima*) were exhibited, two from the Isle of May, in the Firth of Forth, and one from Norway. Of the Forth specimens, one contained five eggs, and the other one egg. The Norway specimen contained five eggs. Dr Duns referred verbally to the wide differences of opinion among naturalists as to the number of eggs deposited, and the weight of the down in a nest. Pontippidan's description of the Edderfugl, 1751, was noticed. Von Troil, 1780, and Henderson's "Iceland," 1818, were also referred to. As bearing on the Firth of Forth specimens, an extract was read from De Saussare's "Voyage

en Ecosse," 1821, describing a visit, under the guidance of Dr Patrick Neil, to the sand dunes between Aberlady and Dirleton, where the nests of the eider duck seem to have been common among the marrun, or shore grass (*Arundo arenaria*). He describes the composition of the nests, the colour of the down and the eggs, and the remarkable tameness of the females. It was pointed out that this passage is valuable as showing that, at a comparatively recent date, the eider duck has nested on the shores of the Firth of Forth as well as in the Isle of May. An interesting note from Mr Agnew, of the May Lighthouse, was read with reference to the nest with five eggs; and it was pointed out that not only have grass and fragments of sea weeds been employed to form the foundation of the nest, and been partially mixed with the down, but also, that amongst the foundation matter of the Norway specimen, a number of small bones occur.

VII. *Zoology of Mid-Lochaber.* By Professor Duns.

(Read 21st December 1881.)

Lochaber embraces the part of Inverness-shire which touches Argyll on the south and west, and Perth on the east. Dividing it for convenience into Upper, Middle, and Nether, the following notes were made within the second. The area is thus comparatively small and compact, and is bounded on the N by the Spean, on the S by the Nevis, on the W by the Lochy, and on the E by the Nevis range of mountains. Its physical features are exceedingly varied. There are lakes, rivers, and mountain torrents; a good deal of plantation in the low ground; the white birch, the alder, the rowan, and the sandwillow (*Salix arenaria*) in the torrent courses and on the lower slopes of the hills; patches here and there of cultivated soil; great peat mosses, and much rank heather-clad surface. The game of the district is carefully preserved, and, as is ever the case in such circumstances, other wild forms are little, if at all, disturbed. My first acquaintance with the locality was made sixteen years ago. Since that time I have visited it on several occasions. Last

summer I spent two months in the district. As the chief object in view was to examine its surface geology, I had much wandering, and found my way, often with difficulty and after trying toil, into many of its little-known quiet nooks and places seldom visited. In these rambles the living forms met with were carefully noted. The stagnant pools on Corpach Moss, at the edge of which I lived, supplied lavish material for the microscope, and abundant employment for rainy days. Insect life was not forgotten, and jottings were made regarding the fishes. I have not had time to work these into shape, but hope on another occasion to lay them before the Society. The present paper embraces the mammals, birds, and reptiles of Lochaber. I plead as excuse for calling attention to a district almost at our doors the fact, on the one hand, of the presence of some forms I had not expected to find, and, on the other, the meagre and unsatisfactory character of the literature of its natural history. Besides, it is of some interest to notice the co-relation between the variety of its physical features and that of its animal forms.

MAMMALIA.*

The common bat (*Vespertilio pipistrellus*); long-eared bat (?) (*Plecotus auritus*); the mole (*Talpa europœus*), Ben Nevis; *badger (*Meles taxus*); *otter (*Lutra vulgaris*); common weasel (*Mustela vulgaris*), Auchandall, Glen Nevis; ermine (*Mustela erminea*); *polecat (*Mustela putorius*); the *pine marten (*Martes abietum*), Lord Abinger's deer forest; the *wild cat (*Felis catus*), among the mountains; the fox (*Canis vulpes*), common; the seal (*Phoca vitulina*), in Loch Linnhe; the *squirrel (?) (*Sciurus vulgaris*), Glen Spean (?); common mouse (*Mus musculus*); brown rat (*Mus decumanus*); water vole (*Mus amphibius*), Glen Nevis, Dorney; field vole (*Arvicola agrestis*), Meall an t'Suidhe; the common hare (*Lepus timidus*); *alpine hare (*Lepus variabilis*), among the mountains; the rabbit (*Lepus cuniculus*); red deer (*Cervus elaphus*), Tomacharish; roe deer (*Cervus capreolus*), Inverlochy Castle grounds; the ox (*Bos taurus*), variety, West

* The forms whose occurrence I set down on the report of others are marked with an asterisk (*).

Highland cattle; the sheep (*Ovis aries*); the ca'ing whale (*Delphinus melas*) has been seen in Loch Linnhe; the common dolphin (*Delphinus delphis*) occasionally visits Loch Linnhe.

Notes.

The bat (*Vespertilio*).—I was several times struck with the difference of size among the numerous bats in the district. While the great majority are evidently pipistrelles, nearly every time I saw them there were one or more that appeared larger than the others. This has led me to give a place in the list to the genus *Plecotus*, with a (?). An intelligent farmer assured me that there are two kinds. The length of the head and body of the pipistrelle is 1 inch 7 lines, while the head and body of the long-eared bat is 1 inch 11 lines. The extent of the wings of the former is 8 inches 4 lines; that of the latter is 10 inches 4 lines—a variation sufficient to make it appear on the wing considerably larger than the other.

The mole (*Talpa europœus*).—I was interested in meeting with one on Ben Nevis, at a height of more than 2000 feet above the level of the sea.

The squirrel (*Sciurus vulgaris*) was said to occur in Glen Spean. An intelligent *gillie* assured me he had seen it there. A young keeper said his father had shot one there fifteen years ago. A correspondent writes that it is found in Glengarry.

Birds.

Golden eagle (*Aquila chrysaëtus*), Ben Nevis, July 16; *osprey (*Haliaëtus albicilla*), Loch Linnhe, September; *common buzzard (*Buteo fuscus*); *rough-legged buzzard (*B. lagopus*), winter; the red kite (*Milvus regalis*), Glen Nevis, June 11; *peregrine falcon (*Falco peregrinus*), Glen Nevis; sparrow-hawk (*Accipiter nisus*), Tor Castle, June 23; hen harrier (*Circus cyaneus*), Aonach Mor; *common owl (*Strix aluco*); *eared owl (*S. asio*); barn owl (*S. flammea*), Lochy Bridge, July 1st, 8th, 13th; swift (*Cypselus murarius*), neighbourhood of Fort William, frequent; chimney swallow (*Hirundo

rustica), common; window swallow (*H. urbica*), common; bank swallow (*H. riparia*), common; goatsucker (*Caprimulgus europæus*), Lochy Bridge, July 20, 27, 29, common; cuckoo (*Cúculus canorus*), June 8, common; spotted grey fly-catcher (*Muscicapa grisola*), common; raven (*Corvus corax*), Tomacharish, July 25; *carrion crow (*C. corone*); hooded crow (*C. cornix*), Glen Nevis, June 11; rook (*C. frugilegus*), common; jackdaw (*C. monedula*), common; starling (*Sturnus vulgaris*), Inverlochy Old Castle, Corpach Moss, Kilmalie churchyard, June 9, 12, 18; blackbird (*Turdus merula*), common; *fieldfare (*T. pilaris*), winter; missel thrush (*T. viscivorus*), Torlundie; song thrush (*T. musicus*), Torlundie; *red wing (*T. iliacus*); hedge sparrow (*Accentor modularis*), Torlundie, July 2; redbreast (*Erithacus rubecula*), Torlundie, June 23; whinchat (*Saxicola rubetra*), Crag Dhub, August 2; bushchat (*S. rubicola*), Auchnadaull, July 2; stonechat (*S. œnanthe*), common; redstart (*Ruticilla phœnicurus*), Achintee, July 27; garden warbler (*Sylvia hortensis*), Inverlochy Castle woods, June 9, July 25, 27; blackcap warbler (?) (*S. atricapilla*), near Tor Castle, June 18; willow wood wren (*Phyllopneuste trochilus*), Torlundie, July 21; *gold-crowned kinglet (*Regulus auricapillus*); common wren (*Anorthura troglodytes*), Inverlochy Castle, June 23; pied wagtail (*Motacilla yarrelli*), Glen Nevis, June 11; yellow wagtail (*Budytes rayi*), June 12; meadow pipit (*Anthus pratensis*), Corpach Moss, June 8; shore pipit (*A. obscurus*), Auchintore, July 5; lark (*Alauda arvensis*), common; ox-eye tit (*Parus major*), Banks of Lochy, June 20; blue tit (*P. cœrulus*), Glen Nevis, June 11; cole tit (*P. ater*), Kilmonivaig Free Church manse garden, July 25; long-tailed tit (*P. caudatus*), Banks of Lochy, near Kilmonivaig Free Church manse; corn bunting (*Emberiza miliaris*), on wall at Claggan, July 5; yellow hammer (*E. citrinella*), Glen Nevis, June 8; *snowflake (*Plectrophanes nivalis*), common over the district in winter; chaffinch (*Fringilla cœlebs*), common; goldfinch (*Carduelis elegans*), common; grey linnet (*Linaria cannabina*), common; twite (*Linota montium*), Ben Nevis, July 12; green linnet (*Chlorospiza chloris*), common; sparrow (*Passer domesticus*), common; bullfinch (*Pyrrhula pileata*), Banavie, June 16; tree creeper

(*Certhia familiaris*), Glen Nevis, June 24; cushat (*Columba palumbus*), Inverlochy Castle, June 9; rock dove (*C. livia*), on the wing beyond Auchintore, July 5; pheasant (*Phasianus colchicus*), Inverlochy Castle; partridge (*Perdix cinerea*); black grouse (*Tetrao tetrix*), common; red grouse (*T scoticus*), common; *ptarmigan (*T. lagopus*), common golden plover (*Charadrius pluvialis*), Meall an t'Suidhe, July 12; the ring-plover (*C. hiaticula*), common; lapwing (*Vanellus cristatus*), common; oyster catcher (*Hæmatopus ostralegus*), common; curlew (*Numenius arquata*), common; common sandpiper (*Totanus hypoleucos*), Glen Nevis, June 24, Tor Castle, June 18; common snipe (*Scolopax galinago*), common; *jack snipe (*S. gallinula*); *woodcock (*S. rusticola*); the heron (*Ardea cinerea*), Corpach Moss, Banks of Lochy, Allt Coire an Lochan, Lochan Meall an t'Suidhe; *bittern (*Botaurus stellaris*), informant had heard of one having been shot long ago; water rail (*Rallus aquaticus*), ditch near Corpach Moss, July 13; corn crake (*Crex pratensis*), common; *wild goose (*Anas anser*); *wild swan (*Cygnus musicus*); wild duck (*Anas boschas*), Lochy, June 18; guillemot (*Uria troile*); Richardson's skua (*Lestris richardsonii*), Loch Linnhe, July 5; kittiwake (*Rissa tridactyla*), Loch Linnhe, July 5; *lesser black-backed gull (*Larus fuscus*); common gull (*L. canus*); brown-hooded mew (*L. ridibundus*); the common tern (*Sterna hirundo*), on the wing, frequent.

Notes.

Golden eagle (*Aquila chrysaëtus*).—One of Lord Abinger's keepers informed me that he "believed a pair of golden eagles were nesting on the steep face of Ben Nevis." The place indicated is the precipitous cliffs on the north-east of the mountain, forming an almost perpendicular front of about 1500 feet high. In the hope of getting a look at the birds, I resolved to walk up the corrie between Ben Nevis and Carn Dearg, but was hindered. On the day after the talk with the keeper (the 16th of July), when toilsomely zig-zagging up the rough stone-covered slope above the lake—Lochan Meall an t'Suidhe—bent on boulder hunting, my attention was drawn to the north by the sharp harsh cry of a

heron. This bird seemed making its way to the stream which drains the loch—Allt Coire an Lochan. Suddenly another bird came sailing grandly round the corner of the precipice, then turned back, wheeling widely, and passed out of sight as quickly as it had come in view. My glass was in its case, and before I could bring it to bear on the bird it had passed away. I had before seen the flight of the golden eagle in the Outer Hebrides, and have no doubt I had now got a glimpse of another, in the heart of even grander surroundings. But I am inclined to think the keeper was mistaken as to its nesting here this season. Inquiries were made of friends who are well acquainted with the mountain, and of others who had recently gone to the top, but they had not seen this bird. It is not very likely that a pair could be nesting in the locality without being seen. A shepherd to whom I spoke afterwards, and who had been about thirty years in the neighbourhood, said he knew the bird well, but he had not observed it for several years. It is thus probable that the bird was a chance visitor. It should, however, be mentioned that the keeper said, "they are seldom seen on the west of the mountain." When it came in view I was preparing to measure a huge boulder of felstone porphyrite lying at a height of nearly 3000 feet. When about 1000 feet higher, and nearing the summit, a dark, grey, thick mist swathed the mountain in a cold, damp, dreary gloom, shutting out the view of everything except the bare loose stones for a few feet around. Out of the gloom, and as if far below me, came a shrill cry—half yelp, half scream,—which I ascribed to the same bird. A farmer informed me that he had seen the golden eagle in Glen Nevis in the winter of 1879-80.

The red kite (*Milvus regalis*).—I quote from my note-book: —"June 11, 1881. On a height to the north-west of Dundhairdghall (Dun Jardil), where are the remains of a vitrified fort, I met an intelligent young farmer, who was on his way across the hills to visit some sheep on a distant part of his farm. 'Are there many large hawks about?' I asked. 'The peregrine falcon,' he said, 'and two sorts of buzzard are met with.' 'But look there,' he exclaimed, as he directed

his long field-glass in the direction of the wild torrent course which separates Meall an t'Suidhe from Ben Nevis on the north-west, 'look there, is that a great sea gull which has been on a visit to the mountain?' A look at it convinced me he was right, when he added, 'No, they are' (for another had come into view) 'the large hawks you were asking about.' Nearer they came and nearer, almost on a level with the eye. The spot on which we were resting was about 1000 feet above the level of the sea. They floated gently across Glen Nevis on motionless wing, and, suddenly, as if they had observed us, by a few rapid forward and upward strokes, they mounted far above us, but not so far as to hide the long wide wings and definitely emarginate tail; and then hovering over head for a moment, they struck away in arrowy speed in the direction of Glencoe. We had been looking at a pair of red kites. It was a rare chance." But such chances come in the field, chiefly, perhaps, because we look for them.

The osprey (*Haliaëtus albicilla*).—Before leaving Lochaber I made out a list of birds, and gave it in charge to a friend who had good opportunity to gather information from gamekeepers and others. None of the birds I had myself seen were included in the list. Two questions were asked in regard to each—(1.) 'Where seen?' and (2.) 'When?' The note appended to this bird is—"The grey eagle was shot at by gamekeeper in September."

Owls (*Strigidæ*).—I was again and again informed by keepers and others that three species of owl are met with in the district. The description of these birds by my informants warrant their being placed in the list. All I have to record is contained in the following brief notes: "July 1—As twilight deepened an owl flitted on soft wing, with rapid but noiseless stroke, past the cottage, which it approached from the direction of the ruined castle. Before it appeared the bats had been out for some time, but no sooner had it come than they passed out of sight, and continued so for about a quarter of an hour, when they again resumed their rapid but spasmodic flight. Had the disappearance any connection with the presence of the owl? Will the owl take the bat as the bat the twilight moth? Could not make out the

species." "July 8—Owl out comparatively early. Seems from the lightish colour of the lower parts to be the barn owl (*Strix flammea*). The bats did not make their appearance for some time after I had seen the owl." "July 13—Heard the harsh screech of the owl. This leaves no doubt that it is the barn owl. I am familiar with the note."

The swift (*Cypselus murorius*).—I had been on the outlook for this bird for more than a week, when, on the 12th of June, a pair were seen skimming close to the surface of the Lochy, confining themselves to a comparatively small part of the river, that, namely, between Inverlochy old castle and a few hundred yards above the suspension bridge. Though looked for, I did not see them again till the 19th of July, after which they might be noticed daily hunting in the same neighbourhood.

Swallows (*Hirundinidæ*).—The red-fronted or chimney swallow (*Hirundo rustica*), the white-rumped or window swallow (*H. urbica*), and the sand-marten or bank swallow (*H. riparia*), are all met with, the last in greatest numbers. I refer to them to note their habit of leaving a favourite hunting area for a day, or several days, at a time. Again and again they might be seen hunting over the mountain sides, or confining themselves to the wide sweep of Corpach Moss, eschewing the course of the Lochy for the time. From many jottings I give the following: "June 12—Swallows in large numbers hunting so close to the water of the river as often to touch it with the tips of their wings." "July 1—No swallows seen to-day in the course of the Lochy." "July 4—A few swallows were observed to-day in the course of the river. Most of them were hunting over Corpach Moss. The river much swollen, and black as peat." "July 7—Swallows skimming all day and evening close to the water. An unusual number of large moths flitting at twilight about the banks of the stream." "July 10—Temperature 59° Fahr. at eight A.M. Numerous swallows in the river course, which they forsook entirely in the evening for the moss and the mountain sides." "July 18—Walked by the 'Lady's Mile'—the road from Lochy Bridge to Banavie—to Kilmallie in the evening, which was exceedingly fine, and, what can be said

of few we have had here, really summer-like. Took two rubbings in the churchyard. Home by the Lochy. Swallows in greater numbers than I have seen before, skimming close, close to the surface of the water, their wings seeming often to touch it. A salmon rose to one! Will there ever be a take? or was this only a curious coincidence?—the salmon and the swallow seeking at the same moment to capture the same fly!" In conversation with the people about, it was easy to learn any evening whether the salmon fly-fishing had been successful during the day. My compassion had gone out towards those generally middle-aged wights, who were daily to be seen, up to the waist in the water, drearily but persistently casting the line from their long rods throughout long hours, and never getting "a rise." And I had longed to save them much trouble by finding for them a guide to success, in observing the habits of the swallows. I am sure it would be a great boon, both as regards patience and rheumatism, if we could formulate the matter thus:

> "Hopeful your gentle art you ply
> When swallows near the water fly!"

But, bringing together all the data available in both departments, I failed to find a rule.

Goatsucker (*Caprimulgus europæus*). — From about the middle to the end of July a goatsucker appeared almost every night about ten o'clock in the neighbourhood of the cottage. Like most of the birds in Lochaber, it seemed to have no fear of man, passing so near you that it might have been knocked down with a stick, or letting you approach it in the late twilight to within a few feet. A favourite resting-place was a bar nailed across the top of the wooden posts of a garden gate, the highway intervening between it and the cottage door, from which its mode of hunting could be watched. Its habits in this respect are the same as those of the garden warbler. Seated on its resting-place, it suddenly made a dart in one direction, and another—and in a moment returned again to its perch, or, taking a longer flight, came back after a f[illegible]tes' absence. Unlike the bats, which frequented [illegible], it came abroad in al[illegible]

weathers. I have seen it, not only when the rain was moderate or falling in drops, but when it seemed a heavy plash, as if a whole lake was being emptied overhead.

The cuckoo (*Cuculus canorus*).—"June 8, 1881—Fort-William fair-day. The fair is held in a field on Claggan Moor, close to Nevis Bridge, and at the opening of Glen Nevis—the river Nevis intervening between it and the Cow Hill—Meall a Cruidhe—the height at the foot of which the north end of the town is built. When admiring the exceeding beauty of the two-year-old West Highland cattle, and the sagacious bearing of the fine collies, suddenly the soft notes of more than one cuckoo were heard near at hand—so near that they seemed in the crowd. It turned out, however, that they were haunting the natural birches on the other side of the Nevis." "June 11—Two pretty large birds in a clump of alder trees, a little below Glen Nevis House. The day bright and beautiful—golden sunlight bringing out the bright green of the alder foliage, and making warm spots on the closely-cropped grass. The birds seemed to be playfully following each other, dallying for a moment on one tree, then hastening with fleet but silent wing to another at a distance. I followed them with my glass from tree to tree, convinced that I was looking at cuckoos, but a good deal put out by notes I had never before heard from this bird. For a time I was inclined to credit the note to some other bird; but one of them perched on the branches a few yards from me, and uttered the peculiar notes—notes liker than any I know to those which make up the cry of the blackbird, when alarmed at twilight by the appearance of cat or weasel, only slower and far mellower." "July 1—Cuckoo seldom heard. Saw and heard one last evening." "July 15—Near Banavie. A young cuckoo alighted on a wire fence about four yards from me. After allowing me to have a good look at it, it flew about twenty yards away. I followed it with my glass, and saw it pick, once and again, something from the heather tufts among which it had alighted. I examined the heather about the place, but saw neither insect nor caterpillar on which it might feed. The bird was one of much beauty, the characteristic plumage

of the young bird being exceedingly fresh and well marked." "July 21—A young cuckoo on a great porphyry boulder at the western foot of Aonach Mor." "August 2—Young cuckoo among the natural birches on the banks of Allt a Mhuiliun, the torrent which, after receiving Allt Coire an Lochan, the stream which drains the lake on Ben Nevis, falls into the Lochy near Ben Nevis distillery. I could not find out how much longer the young cuckoo lingers here, the impression in the district being that no cuckoos are met with later than June. As the young cuckoo seems to be a silent bird, its absence is assumed when its note is not heard."

Hooded or grey crow (*Corvus cornix*).—This bird is common. I noticed a pair on the lowermost slope of Dundbhairdghall, Glen Nevis, on the 11th of June, one of which attracted attention. The parts which are usually a dull leaden-grey, were of a distinctly marked, though dirty, white colour.

The starling (*Sturnus vulgaris*) and the lark (*Alauda arvensis*).—I bracket these widely-separated birds for a reason obvious to all who remember recent discussions relative to the alleged influence of the former bird on the latter. I do not believe in the gradual disappearance of the lark over Scotland generally. In its rarity in districts where it was once abundant I do, but it appears to me that local conditions other than the increase of the starling, which is not to be questioned, might be pointed to in trying to account for this. Changes in farming, increase of egg gathering, and the increase yearly of capture by bird dealers, are all influential factors in thinning the numbers of the lark, especially in the neighbourhood of the great centres of population. I had come to believe the impression of long, long ago, that the whole lift sounded with the music of larks, as they mounted higher and higher to the deep blue overhead, was no more than an exaggerated dream of early childhood. But if any one wishes to see that it was not a dream, he has only, in June or July, to find his way to Lochaber, and to take a long day of sunshine to wander about Corpach Moss, which is a favourite resort of this bird. On the 8th of June I counted eleven "singing at heaven's gate" at the same time. What an opportunity, I thou[illegible] ench the assertion of the

first of the recent writers to the *Scotsman*, that the lark thrives only where there are no starlings. I had looked for the latter bird, but hitherto in vain. The next day, however, I noticed a great flock of starlings passing from Inverlochy old castle away to Corpach Moss. A week later I observed another and larger flock near Kilmalie church, in company of a few rooks and many jackdaws. Only a few years ago the starling was a rare bird in this district where it is now plentiful, but no diminution of the number of larks seems to have taken place. "June 18—Starlings very numerous about the ruins of the old castle, while several larks are singing gaily high over a hay field adjoining it."

Stonechat (*Saxicola œnanthe*).—"June 19—A young white-rumped stonechat on a wall at Claggan, with tiny tufts of down still on its head. It sat for a while within arm's length, uttering its sharp hard *tweent, tweent, tweent,* while the parent birds were hopping restlessly about, as if alarmed for its safety, and anxious to convince it of danger by their well-known harsh notes—*creks, creks, creks.* The bird at length took alarm, and flew six or eight yards to a stone half concealed by a tuft of heather, where it sat in silence, while the parent bird went in a different direction, uttering now not their usual note, but one so very like the *tweent, tweent* of the nestling as might deceive even a close observer. Is this a *ruse* to beguile an intruder away from the young?" "July 12—Met with the white-rumped stonechat on Meall an t'Suidhe, at a height of 1500 feet.* Several birds which I

* Snowflake (*Plectrophanes nivalis*).—When in Lochaber I was several times asked what the black and white bird in Glen Nevis was? It did not occur to me that this might be the snowflake. Macgillivray thinks it sometimes breeds in the Grampians, where he had seen several in August. After I returned home, the following note reached me:—"6 Greenside Place, Edinburgh, September 10, 1881. Dear Sir,—May I take the liberty of asking whether you are aware of the snow bunting frequenting Glen Nevis during summer? On the 1st of August I observed a pair of birds sitting on a stone about 200 yards beyond the cottage where the vehicles have to stop. So far as I could judge from plumage and shape, they appeared to be snow buntings, but being a beginner I may be wrong. I learned from a gentleman in Fort William that you were in the habit of visiting the glen, and this is my excuse for troubling you with the question. An answer at your convenience will greatly oblige your obedient servant,—Thos. Wright."

had counted on finding in Lochaber were not met with, as the merlin, kestrel, kingfisher, dipper, and especially the ring-ousel. The last named I have seen in other parts of Inverness-shire, and plentifully in Ross-shire.

I conclude these somewhat hasty and rambling jottings with a general extract from my note-book: "June 18—Temperature at 8 A.M. 62° Fahr. Unusually high. Very heavy shower between 7 and 8 A.M. Wind still strong and gusty. Walked about two miles up the west bank of the Lochy. Huge masses of *cumulus* resting like mountains of unsunned snow on the horizon. The zenith, deep, deep sapphire. Showers came with strange suddenness. Wild flowers in wondrous wealth on the low banks of the river—milk worts, euphrasy, wild hyacinths, large purple cranesbills, etc. When sheltering from a shower in a small clump of alders, goat willows, and wild roses, a small bird struck up a note new to me, in the heart of an alder bush near at hand. My presence evidently disturbed it, for it ceased to sing. Examining the bush with my glass, I noticed a bird about the size of a sparrow, head black, wings and tail uncertain brown, back greyish, with tints of yellow. I got only one good look at it when it left the bush. Tried hard, but in vain, to see the breast and under parts. What was it? Not the cole tit, with which I am very familiar. What?"

On my return to Edinburgh, I sought for an answer. And now I have the very strongest impression that the bird was the black-capped warbler (*Sylvia atricapilla*). It is set down as such in the foregoing list, with a (?). The Society will remember that in June last many letters found their way to the *Scotsman*, calling attention to the presence of this bird in different parts of the Lowlands, as the so-called nightingale. If the form now referred was, what I came to believe, this warbler, then we have here another instance of the much wider distribution of some birds than was assigned to them even a year or two ago.

I resume the extract: "While waiting in this shelter, a sandpiper (*Totanus hypoleucos*) discovered my whereabouts, and made a great noise, piping lustily [illegible] the bushes, occasionally uttering a scream [illegible] in

infant in sore pain than any other sound. Farther down the river was a lone mallard quietly floating in a deep pool, his mate, no doubt, being near at hand in safe hiding with her young. Then a solitary oyster-catcher from Loch Linnhe or Loch Eil came flying up the river course, low to the water, and uttering no cry." The jottings might be multiplied, but let these suffice. They show how much there is to exercise the habit of the eye in trying to acquaint one's self with the birds of Lochaber.

Reptiles.

The slow worm (*Anguis fragilis*), midway between Bridge of Lundy and Auchandall, east side of the road, July 2.

The adder (*Pelias berus*), crushed on the highway not far from Garelochy, July 31.

Common frog (*Rana temporaria*), Ben Nevis, at a height of about 2500 feet, July 16.

Common toad (*Bufo vulgaris*), Torlundie, July 2.

Smooth newt (*Lissotriton punctatus*), Corpach Moss, July 29.

The species given in this list are—*Mammalia*, 26; *Aves*, 91; and *Reptilia*, 5.

VIII. **Hysgeir, off Canna, and its Bird Life; with notice of the breeding of the Pintail* (Anas acuta, *L.*) *there in* 1878 and 1881. By John A. Harvie-Brown, Esq., F.Z.S., F.R.S.E., etc.

(Read 21st December 1881.)

I have already contributed some accounts of other outlying rocks and skerries, and their bird life to the Natural History Society of Glasgow,† and to the Norfolk and Nor-

* Regarding the topographical value of the names of Haskeir and Hysgeir, with their variations, I have received assistance from Mr J. Macpherson; but I will not speak of that here, as a better opportunity offers to me to do so when speaking of Haskeir, off North Uist.

† "Barra Head and its Bird Life" (*Proc. N. H. Soc., Glasg.*, 27th April 180); "St Abb's Head and its Bird Life" (read 1881, not yet published).

wich Naturalists' Society,* along with some accounts of other Scottish Bird Haunts.

This year—1880—I visited several of the outlying Hebrides, and since then, I have drawn out some remarks upon three of the groups visited—viz., Haskeir, off North Uist, the Flannen Isles, west of Lewis, and Hysgeir, off Canna—the subject of the present notice, which may be considered as one of a series of papers upon "British Bird Haunts."

My visit to Hysgeir, off Canna, in June of the present year, was a tolerably leisurely one, as I was enabled to spend nearly four hours upon the rocks; but my observations on their birds, I give subject to future amendment and additions, because a very large portion of my time whilst on shore was spent in watching and in stalking the great grey seal (*Halichœrus gryphus*, Fabricius), which is abundant there. Of these animals and their Scottish haunts, I may have more to say at a future time. Notwithstanding the time spent thus, in crawling through plashes of slippery tangle and green sea-weeds, often with my head and eyes in the worst possible positions for extensive observation, I managed to devote more than an hour and a half to a wider ramble over the island, following a more erect and human-like mode of progression, and to form, perhaps, a tolerably comprehensive idea of its resident bird life. The rocks of Hysgeir lie about 6 miles south-west of the island of Canna. Upon close approach one is at once struck by the wonderful regularity of their basaltic structure, the whole group being composed of regular pillars fitting to one another like the cells in a comb of beeswax. The pillars are small—about 8 inches in diameter—forming throughout the group an irregular causeway, or, where at all precipitous, steps at irregular heights, providing most convenient landing-places all round its shores, only slippery and awkward where the tangle and dulse and sea-weeds adhere to them below the high tide mark. Washed

* "The Shiant Isles and their Bird Life," to which my friend Dr Heddle, of St Andrews, kindly added a "Sketch of the Geology and Mineralogy of the Shiant Islands" (*Trans. N. and N. N. Soc.*, vol. iii.), etc.

up by the roll of the ocean waves, and lodged amidst the crannies or miniature vöes which traverse the islands in different directions, or piled up in some sheltered hollow or bay, are heaps of rounded pebbles and boulders, from the size of a walnut to several tons in weight, belonging to far different formations than the basaltic bed on which they lie. To catalogue these erratics would have consumed our whole time. Whilst I was wallowing in green rock pools, and creeping over slippery ledges, mayhap my friend Heddle pursued the dryer subject—dryer only in the superficial and visible sense, I mean, for, without doubt, even a plain unvarnished list of stones found on Hysgeir, off Canna, would afford much curious and deeply suggestive matter for thought to Boulder Committees and geologists generally. In one or two places—sheltered nooks and crannies—shell-sand had accumulated, and even these small patches had their influence upon the bird life, for over them lightly tripped the yellow feet of the ringed plover, and the trill of an occasional dunlin told me that this species also visited these barren rocks for food if not for breeding purposes. All around the main island, but more especially toward the west side, are numerous skerries, sunken or tide-washed, and dangerous to ships or fishing-boats. These stretch away nearly a mile and a half to westward, and form an angry boiling caldron when the swell comes in off the sea. Here and there amongst their intricate channels, or reposing on the lower basalt pillars, numerous Great Grey seals were seen at the time of low-tide.

On these outlying rocks there is no herbage, and on the main island only a few small patches on the higher levels, or dryer hollows, out of reach of the salt-sea brine. Such grazing as there is, however, is wonderfully succulent and nutritious, so much so that a certain number of cattle are landed every year, which in a few weeks' time surpass in condition the cattle of Canna itself, rich though the herbage of that fair isle undoubtedly is. Curious to relate, near the centre of the island and close to a rudely built cairn is a spring of fairly good water from which both cows and men can drink. Our guide from Canna—Donald M'Isaac—drank

of it to-day. Not far from the cairn are numerous rain pools, but the only very large one lies at a lower level than the spring, and is occasionally entered by the higher tides.

Hysgeir in general shape, especially at the time of high water, resembles an irregular crescent, or new moon, with the concave side facing northward, and the convex side southward. At low water most of the principal rocks are connected, but not the western skerries, some of which are sunken, and some elevated above high tide, but all water-swept or drenched with spray. At high water, the main rocks are cut up by deep, narrow vöes, over which in most instances a man could step or jump. Along these miniature canals the great seals find their way to tidal pools and landlocked bays. The principal of these landlocked sheets of water is towards the south side, is about a gunshot across, and is much frequented by the seals when not much disturbed. In this deep calm basin also, the lobster-fishermen who come out from Canna find shelter for their smacks in stormy weather, and are sometimes detained here for a week at a time, and this, too, when to lie-to outside would be almost certain destruction. We found a rude shelter of drift-wood which had been used by them, and about a score of potatoes, and many shells of sea-birds' eggs around it—the remnants of a rude repast. In the month of November parties of the natives of Canna go out to club the seals, as old and young endeavour to escape down the narrow gullets or vöes. Three years ago 27 were thus slaughtered, mostly young ones. We found also the carcase of a lately killed specimen, from which the blubber had been carefully flensed. It was in a considerable stage of decomposition, so after a vain attempt to sever the head from the body, I allowed it to remain, the more readily that it was not by any means a large example. Fishermen from Canna—we had learned in the morning—had forestalled us, and had sheltered in the seal's pool for a day or more. Thus our chances of getting a specimen ourselves were correspondingly lessened.

Hysgeir is a low basaltic rock, perhaps not more than thirty feet high at its highest points, which latter are situated towards the east horn of the crescent, and in the centre. The north side is the best to land upon if seal-shooting is desired, but

the east side is the best of all for all other purposes, such as egg-collecting or lobster-fishing, as it is usually the best sheltered from wind and wave. To land on the west horn of the crescent is usually a hazardous attempt. Fishermen, if they see a storm approaching, however, make for the south side, and enter the narrow vöe leading to the seal's pool, and this they endeavour to do before the storm reaches them. Once within, they lie snugly moored and safe from any wind.

We landed upon the north side of Hysgeir upon the 16th of June 1881—I, to stalk the seals with the assistance of our guide M'Isaac, Heddle to examine the geognosy and mineralogy of the rocks, and my friend U——, who had accompanied me also to Haskeir and the Flannens, to scramble generally over the rocks, and search for eggs. My quest for seals resulted in the stampede of about twenty huge grey giants,—after an ineffectual fire of S.S.G. at 60 yards, with a huge eight bore double-barrelled duck-gun,—and in the death of a splendid fellow, and his subsequent loss amongst tall tangle on the south shore. After this seal-episode, I turned to the bird life. As I came back towards the landing-place, I met Dr Heddle, who held in his hands four ducks' eggs. He had flushed the bird from the nest, and lifted the eggs, but could not be sure of the species. We then took the down from the nest. At the time the eggs appeared to me most closely to resemble those of either the long-tailed duck, or the pintail, but their identification had to remain over until the downs could be compared. Amongst the down were one or two small feathers, which I carefully preserved. I had some idea of gadwalls, but suppressed that in favour of the pintail, and this proved afterwards to be correct, and I was glad afterwards to have the opportunity of finding my friend Mr Robert Gray—our valued secretary—arrive at precisely similar conclusions by a comparison of the down, whilst at the same time the long-tailed duck's parentage was at once negatived, when a packet of down of that species was opened for the first time since its arrival from Russia in 1875. This is the principal result of our visit to Hysgeir from an ornithologist's point of view. I

have brought the specimens for the inspection of the Society along with the down.*

* Mr R. Gray (Birds of West of Scotland, p. 368) notices the occurrence of a pair of this species on the Loch of Slains in Aberdeenshire, on 4th May 1866, as recorded by Mr Angus, and of the death of probably the same pair three days afterwards, as they flew up the river Ythan. N.B.—Had I been guilty of this death, I should not have bruited it.—No doubt these birds would have reared a brood, had they not been destroyed; and it does seem unnecessary now-a-days to kill the parents of the nest, even in order to identify the eggs, if, instead, down is procurable. Specimens of the pintail have been shot, as Mr Gray informs us, in "almost every county north of the Tweed;" but in the Hebrides it appears to be of rare occurrence (*Proc. Roy. Phys. Soc.*, 1879-80, p. 361).

Two were seen in Tyree by Mr J. Henderson in the winter of 1878-79 (*Proc. N. H. Soc., Glasg.*, 30th Sept. 1879); and Mr R. Gray exhibited one, which was obtained in Uist in 1879, to this society. I am not, however, aware of any positive record of its having bred in Scotland, previous to the present one.*

Since writing out the above, and after my first and second comparison of the downs and feathers, I wrote to Professor Newton of Cambridge, telling him of the discovery. In reply he says:—"A pintail's nest on Hysgeir is a very curious circumstance—for the bird, so far as I know, is not at all of a marine character," and he adds:—"I confess to wishing that the evidence lay in something more firm than down—about which I have often had doubt." He adds also that:—"I believe pintail's eggs are, as a rule, indistinguishable from those of the long-tailed duck; and I should never be surprised at a nest of the latter being found anywhere among the Scottish Islands."

After replying that I felt great confidence in the authenticity of my pintail's eggs, I made a third careful comparison, the results of which put beyond a doubt in my mind the correctness of my identification, and I beg to hand round a volume of Captain Feilden's and my egg book for inspection. In it will be seen:—(*a*) a spray of down from a Russian nest, taken in 1875 by myself; (*b*) a spray of down taken from the Hysgeir nest; (*c*) a flank feather from the Hysgeir nest; (*d*) a flank feather plucked from a pintail duck in our collection; (*e*) a flank feather taken from the Russian nest; and lastly, as *negative* evidence, a much smaller spray of down, taken from a nest of the long-tailed duck in Russia. At the same time I ought to let you know that a full comparison which I have also made of the downs in bulk, shows the difference even more distinctly. I would here refer you to remarks on the subject of the differences between the downs of various species of duck, by Mr Seebohm and myself, in the *Ibis* for 1876, p. 436, a copy of which volume I have also brought for your inspection, and beg leave to hand round. It will be seen that we have placed the downs of the pintail and the long-tailed duck in two totally different classes—A and D—the former belonging to the "*White- or light-tipped class*," the latter to the "small dark, without-white-tips" class, and it will further be noted that "the downs were examined in bulk in a clear but not too bright light, and *in the absence of direct rays of sun-light*" (*op. cit.*, p. 436).

* It has since bred in Sutherland in 1882.

Though I do not hold our table of downs to be infallible, yet, so far as it goes, I believe it will be found to afford really good and serviceable means of identifying ducks' eggs. Were the table completed by descriptions, on similar lines, of other ducks' downs, taken from the nests, and carefully identified—in the first instance—I consider it would form a really good aid to the oologist.*

The following is a list of the species of birds found there by our party, along with such remarks as I have deemed it desirable to make to relieve the barrenness of a mere list. I would like to have added a list of the flowering plants we found on the more verdant portions, but our time did not admit of this being done carefully, so I think it better to omit it for the present, than to offer an imperfect list.

List of Birds.†

Great Black Backed Gull (*Larus marinus*, L.).
Lesser Black Backed Gull (*Larus fuscus*, L.).
Herring Gull (*Larus argentatus*, L.).

All these gulls formed one colony over the larger portion of the island, but principally, as was to be expected, upon the more verdant portions. The nests were much scattered, and it was difficult to arrive at any conclusions as to their respective numbers. The great black backed gulls were, however, the least abundant.

A considerable colony were breeding amongst the protruding tops of the basaltic columns towards the western horn of the crescent, laying their eggs on the more level or cup-shaped spaces between the stumps, which at this part were richly clothed in grey rock-lichens. The sole materials of the nests were small shreds of broken lichen, or dry grass; and often no materials at all were used. The fishermen had already robbed the nests, or, otherwise, the birds had only just begun to lay, as the largest

* I need not say I will be much indebted to any one who can assist me to complete the table given in the accompanying vol. of the *Ibis*, by specimens or descriptions—the former preferred.

† The scientific names are on the authority of H. E. Dresser's latest "List of European Birds" (6 Tenterden Street, London, 1881), which is our latest authority.

number of nests contained only one egg, and others, two; and one nest only had *three.* This latter number made me pay more particular attention to the species, many individuals of which kept hovering around and overhead, and I carefully searched for a common tern (*Sterna fluviatilis*, Naum.), but quite in vain.

As far as I could make out, all belonged to what I consider the commoner species—*Sterna macrura*, Naum.

Ringed Dotterel (*Ægialites hiaticula*).—Close to the sandy patches before mentioned, I saw three or four pairs, but was too intent at the time on the seals to search for the nests.

Dunlin (*Tringa variabilis*).—Two of this species were seen at the same place and time as the last-mentioned species.

Rock pipit (*Anthus aquaticus*).—Very common.

Eider Duck (*Somateria mollissima*).—Also abundant.

Teal (*Anas guerquedula*).—We did not meet with this species, nor is it apparently a place one would expect to find them, but in November of this year when returning to Oban from Ardnamurchan, Mr John Swinburne told me he found a teal's nest on Hysgeir in 1878 when paying a visit to it in his father's yacht from Eilean Shona, near the mouth of the river Shiel.

Pintail (*Anas acuta*).—The circumstances of the "find" of this *rare* Scottish breeding species are already related. Mr Swinburne in 1878 also took a nest of duck's eggs on Hysgeir, and described to me the situation of the nest, which exactly tallied with the position of that found by Dr Heddle. I asked him if he found his nest near to the cairn of stones, and he replied he did. Later, Mr Swinburne sent me a rough outline of Hysgeir, drawn from memory, indicating the position of the nest, and it certainly closely corresponds with that of our nest. He writes, "The eggs were eleven in number. The nest was placed among a quantity of rank vegetation. It was composed chiefly of down, which unfortunately was not kept separate from a quantity of eider-down. Owing to the gathering darkness, it was impossible to distinguish the species of the old bird as it rose from the nest." But from his description of the eggs—one of which he will send me on his return to Eilean Shona—I think it likely that the present species has bred before in Hysgeir.*

* He has since done so, and it has every appearance, though broken, of being that of the pintail.

Oyster-catcher.—(*Hæmatopus ostralegus*).—Common.

Guillemot.—(*Uria troile*, L.).—A few pairs seen, but no eggs obtained.

Shag.—(*Phalocrocorax cristatus*).—Several resting places observed, and a few birds seen, but no eggs found.

This completes the short list of the birds ascertained by me to visit or breed on Hysgeir. More constant acquaintance with the locality would no doubt add to the list. Still, it serves to give some idea of its bird life.

Mist and rain now came down over the lone rocks of Hysgeir. The good yacht "Crusader" seemed impatiently to surge to and fro off the shore, tacking off and on awaiting our return; and the note of the captain's fog-horn reminded us of our lengthened stay on the island, and of the rising sea outside the rocky fringing reefs. The high hills of Rum were already blotted out from our vision, and even Canna seemed dim and obscure; the wind, too, was freshening from the south-west, and accordingly we once more scrambled on board, and ran for our haven in Canna, which we reached in about an hour and a half.

We had circumnavigated Canna, and had landed on its north shore, and taken a few eggs of razorbill and other rock birds; and in the evening Dr Heddle and I walked over and inspected the precipices of Sanday and their bird life, viewed the great isolated stacks of *Dun Creag* and *Dun Mhor*, facing across the Sound of Canna to Rum; but another visit will be required before I can speak definitely upon Canna and its bird life, as, owing to wild and stormy weather, we failed to investigate that interesting island as fully as we desired. Nevertheless the notes made casually in 1881 may come in useful again.

IX. *On some Fossil Myriapods from the Lower Old Red Sandstone of Forfarshire.* By B. N. PEACH, Esq., A.R.S.M., F.G.S., of the Geological Survey of Scotland. [Plate II.]

(Read 18th January 1882.)

Some of the fossils now to be described as Myriapods have long been known, though their true nature was not recog-

nised. In the first edition of his "Advanced Text-Book," the late David Page affixed the name of Kampecaris Forfarensis,* or the Forfarshire grub-shrimp, to one species, under the impression that it was an anomalous larval form of Isopod crustacean, and subsequent writers seem to have acquiesced in his dictum. Salter and Woodward, in their "Chart of Fossil Crustacea,"† give a figure of the Kampecaris Forfarensis, which is evidently taken from a specimen presented by the late Sir Philip Egerton to the Geological Survey, and now in their collection in Jermyn Street, London.

In the year 1873 C. W. Peach, while arranging the geological collection belonging to the Watt Institute, Dundee, saw that one of the specimens from the Lower Old Red sandstone of Forfarshire, now about to be described, was a portion of a myriapod. About the same time, Walter MacNicol of Tealing, near Dundee, an enthusiastic local geologist, presented him with two other specimens from the same county. All these Mr Peach showed to Henry Woodward, the great authority on fossil Arthropods, who corroborated his opinion, comparing them at the same time with the carboniferous Euphoberia of Messrs Meek and Worthen, from which genus, however, they differ in some very essential points. Last year C. W. Peach drew my attention to these fossils, and I saw that one of these myriapods was the Kampecaris of Page. To make certain of the matter, I endeavoured to obtain some of Dr Page's specimens, and I applied to James Powrie, Esq. of Reswallie, F.G.S., whose collection of Forfarshire fossils is well known to be the best extant. Mr Powrie generously put his specimens at my disposal, and one of these, a slab with the remains of several different individuals of Kampecaris, had been presented to him by Dr Page himself. Professor Archibald Geikie, LL.D., F.R.S., Director-General of the Geological Survey of Great Britain and Ireland, has kindly brought down to Edinburgh the specimen figured by Salter from the Jermyn Street collection for my inspection. Both Mr

* Page, "Advanced Text-Book," 1st ed., p. 135, fig. 4.

† Chart of Fossil Crustacea, arranged and drawn by J. W. Salter, A.L.S., F.G.S., and Henry Woodward, F.G.S., F.Z.S. London, 1865.

Powrie's and the Survey specimens bear testimony to the correctness of my surmise.

After a long and careful study of all the specimens obtainable, I find that there are two distinct forms which have both probably been included in the genus Kampecaris. The characters of these are such as to warrant their being looked upon as belonging to two distinct genera of Chilognathous Myriapods, which differ from all recent and all hitherto-described palæozoic genera in having each body ring single, and each bearing only one pair of legs.

Genus KAMPECARIS (Page).

Body long and cylindrical, with scarcely any taper towards its anterior extremity; almost circular or slightly depressed in cross section, and composed of numerous alternately larger and smaller somites, each bearing only one pair of limbs. Test granulated and supplied on dorsal scutes with occasional papillæ supporting spine-like hairs; lateral lamellæ small.

The retention of Dr Page's name for this form is proposed, as it is evident that it is the one that has been figured.

KAMPECARIS FORFARENSIS (Page).—Pl. II., figs. 1-19.

Body long and cylindrical, with little or no taper anteriorly, composed of several free segments which are larger and smaller alternately. Sixteen of these in one specimen measure on an average 20 mm., the average breadth being 4·5 mm. for the larger and 3·5 mm. for the smaller somites. The latter are a little less than half the length of the former. The dorsal scutes occupy about two-thirds of each somite, those of the larger ones being puffed out and bearing on their sides slight protuberances or lateral lamellæ, which are not found on the smaller. The sternal plates occupy the other third of the rings, and are pierced near their external margins by the holes for the insertion of the coxæ of the limbs which are oval or reniform, and placed with their long axes obliquely to the length of the body, and with their anterior ends looking inwards, so that the coxæ of the succeeding somites

overlap. The limbs, of which each segment bears only one pair, are on the anterior segments longer than the breadth of the segment to which they are attached, and are made up of seven joints. The coxæ in their flattened state are about 1 mm. broad, the legs then expand towards the distal end of the third joint, whence they taper to a point. The third joint is much the longest, the others are sub-equal in length, and the leg is terminated by a single claw. Where not crushed, the legs are nearly circular in cross section, and there is no appearance of spines at the articulations. The head, which appears to be composed of several coalesced segments from its being divided into several areas by deep sulci, is, when seen from above, roughly triangular in shape, with the sides slightly bulging. The anterior part is occupied by a pentagonal area, which is deeply pitted with numerous circular depressions of the test. Lapping round three sides of the above is a narrow area which bears near each of its anterior extremities the pits into which the basal joints of the antennæ are articulated, the inner margin of the pits being strengthened by crescent-shaped ridges. The back part of the head is occupied by a narrow area which extends across from side to side, forming as it were a nuchal plate. Through about half of its length the anterior margin of this area abuts upon the preceding one, triangular eye-spaces forming the boundaries of the remaining quarters on each side. The eye-spaces thus placed at the postero-lateral margins of the head are large and triangular in form, and depressed somewhat below the general level of the head plates. They are protected anteriorly by raised ridges of the test which pass inwards from the lateral margins at angles of about 45°, and lose themselves in the sulcus which divides the nuchal from the antennal area. The eye itself is made up of numerous facets which are arranged in oblique rows, the posterior end of each row being inclined downwards and outwards, the facets being so numerous and so close together that the eye simulates a compound one. Both the eye and the protecting ridge in all probability represent original segments. The antennæ, of which three joints on each side have been preserved in one specimen (Pl. II., fig. 1), appear to be constructed on the type

of the recent Chilognaths; each joint is funnel or club-shaped, being much the thickest near its distal articulation. The basal joint is short and almost cylindrical, the second joint much larger than either it or the succeeding one. Another specimen (Pl. II., figs. 1*b* and 1*c*) exhibits a doubtful fourth joint, but it is most probable that even in this case some joints are still amissing. The test, which is horny in character and still retains its brown colour, is minutely pitted or punctated all over. On the dorsal scutes it is granular, and in places is raised into papillæ, which probably supported small hair-like spines, some of which are found pressed into the test or flattened against it, and where the animal has been fossilised as a cast small holes are observable passing from it into the matrix. The somites have been held together by flexible and wrinkled skin, which is preserved in some specimens (Pl. II., fig. 1*b*), and the whole animal must have enjoyed an exceeding flexibility. In a specimen preserved in the round (Pl. II., fig. 1*e*) the body looks like a string of larger and smaller beads. There is no evidence that it rolled itself up in the manner of the recent Iulus, the probabilities being against such a supposition, for the legs are so much longer than the width of the body that rolling up would afford them but little protection.

Fragments of ten different individuals referable to the above genus and species have been studied for the above description, and though in three specimens the head has been distinctly seen, in no case has the posterior extremity of any individual been observed. In several cases from sixteen to twenty segments have been found adhering together, and this circumstance would tend towards the supposition that the segments of this species and genus were fewer in number than those of the succeeding genus.

Relative Dimensions of Two of the Best Preserved Individuals of the Kampecaris Forfarensis.

No. I.

Specimen from which fig. 1 is taken, which is fossilised, back upwards.
Length of head, 2 mm.
Greatest breadth of head, 2·75 mm.

Length of three joints of antennæ, 1·5 mm.
Length of middle joint of antenna, ·75 mm.
Length of first eleven segments of body, 7 mm.
Breadth of body across one of the larger segments (the eighth), 3 mm.
Breadth of body across one of the smaller segments (the seventh), 2·5 mm.
Length of leg attached to fourteenth segment, 4·5 mm.
Length of second segment of leg, 1·5 mm.

No. II.

Specimen for which fig. 1*b* is taken, fossilised sideways.
Length of head, 5 mm.
Breadth of head, 5 mm.
Length of sixteen segments, 20 mm.
Breadth of larger segments, 4·5 mm.
Breadth of smaller segments, 3·5 mm.

Genus ARCHIDESMUS, nov. genus.

Body long, fusiform, depressed, composed of very numerous alternately larger and smaller free segments, the dorsal scutes of the larger being produced into large rounded lateral lamellæ, the smaller somites being mere rings interposed between the larger. Each somite bearing only one pair of six or seven jointed depressed and flattened legs, which are produced into spines at the articulations.

The genus is named from the general likeness of these Old Red fossils to many members of the recent Polydesmidæ, with which family they are very nearly allied; indeed, were it not that each segment were free in both this genus and in Kampecaris, they would rank themselves along with Craspedesoma, which genus they closely resemble in the character of the eyes, the antennæ, and the lateral lamellæ. They might with propriety be erected into a sub-family of the Polydesmidæ, for which the name of "The Archidesmidæ" seems not inappropriate.

ARCHIDESMUS MACNICOLI, nov. spec.—Pl. II., figs. 2-2*a*.

Body composed of very numerous segments; is flattened horizontally, swelling gently from the head to about the sixteenth segment; from this it preserves its general breadth or only tapers slightly till the twentieth segment from what appears to be the tail is reached, whence it tapers rapidly

backwards, diminishing to half its breadth in the space of sixteen segments. The somites are smaller and larger alternately, the smaller being anterior to the larger. The dorsal scutes occupy about two-thirds of each body ring. Those of the larger somites, with the exception of those near the tail, are produced laterally into broad expanded lobes or lateral lamellæ, which extend outwards to a distance of half the breadth of the body of the segment itself, and are directed slightly backwards. These lamellæ in the fossil state show a more or less circular depression, probably due to their collapsing. The backs of the dorsal scutes of these segments are further ornamented with a double row of papillæ, which, in all probability, supported spine-like hairs. When the body begins to diminish towards the tail, the lateral lamellæ appear to decrease also, and seem to disappear altogether from the last few segments. The smaller segments bear no lateral lamellæ, and are mere rings interposed between the larger to allow of flexibility. Sternal plates not observed. The legs, of which there is a pair to each segment, whether large or small, are stout and flattened, and are a little longer than the breadth of the segment to which they are attached. They are made up of six or seven subequal joints, the second from the body being slightly the longest and most depressed. They end in simple claws, and two or three spines are given off at the distal articulation of each joint.

The head, in the only case where preserved, is seen from above and is pyriform with its wider end turned backwards. It is divided into at least two areas by a constriction or sulcus, which passes in from each side, and becomes almost lost in the mid line. The hinder area bears two swollen cheek-like prominences at its posterio-lateral sides. Upon these prominences are several small tubercles which appear to be the eyes, the position of which they occupy when such are present. Six tubercles are seen on one side, and there have been more which are now crushed. In front of these, crescent-shaped tuberculated ridges partially encircle the depressions, out of which the antennæ take their rise. Only one joint of the right antenna is visible, while two joints of the left can be made out, the second joint being

longer than the first, and bent back from it at a considerable angle. There is an appearance in the slab in which the fossil occurs as if this antennæ extended further, but in such a crushed state that the individual segments are not recognisable. Two specimens belonging to this genus have been studied, and from the depressed character of the animal and its having possessed such wide lateral lamellæ, they have both been fossilised back up. The following measurements give the proportions of such part as have been preserved, it must be remembered, in a collapsed state:—

The specimen from which fig. 2 and *2a* are taken measures—

From head to tail, along the curve, 47 mm., the body consisting of about seventy-seven segments, not counting the head.

Length of head, 3·5 mm.

Breadth of anterior portion of head, 2 mm.

Breadth of posterior portion of h ead, 2·5 mm.

Breadth of body, including the lateral lamellæ across the twentieth segment from head, 5·25 mm.

Breadth of nineteeth segment, which bears no lamellæ, 2·75 mm.

Breadth of body at about the twentieth segment from tail end, 2 mm.

Breadth of body close to tail, 1 mm.

Length of leg attached to twentieth segment from tail, 3 mm.

Breadth of above leg at base, ·5 mm., increasing slightly to end of second joint.

Length of leg attached to above segment, which measures 1 mm. across close to tail end, 3·5 mm. The legs, therefore, appear to increase in length backwards.

In the fragmentary specimen from which fig. *2b* is taken, there is scarcely any appreciable taper, the inference being that the middle portion of the animal only is preserved to us. It measures 50 mm., and shows sixty-two segments. The average breadth of segments across the lateral lamellæ is 6 mm., the smaller intermediate segments only measuring 3 mm. It is easily seen that this latter fossil must represent the remains of a much larger individual than that shown in fig. 2.

This species is called after Walter MacNicol, Esq., the finder of the specimen from which fig. 2 is taken, who has done so much towards unearthing the fauna of the Lower Old Red Sandstone of Forfarshire.

All the specimens studied, with the exception of the one from the Jermyn Street collection (fig. 1*e*), have the horny material of the test still preserved, and still retaining the deep brown colour. The dorsal scutes must have been of considerable consistence. The animals are not preserved in the round like those found in ironstone nodules or in Sigillarian trunks where fossil myriapods have usually been hitherto obtained; but they occur as hollow flutings, and the legs, antennæ, and the lateral lamellæ are found in the same condition. The reason for this seems to be that the dead gallyworm, when borne to its watery grave, still retained its rounded form, and on sinking to the bottom made a slight depression on the sandy mud. At length, being entirely enveloped in sediment to a considerable depth, and its perishable organs becoming decomposed, the pressure of the superincumbent mud and water was sufficient to make the tubular body to collapse; but as it had been already dimpled into the underlying layer, instead of being flattened out it became folded together into a double-walled gutter, the concave side of which was originally the convex side of the animal that lay uppermost. The legs being also tubes are treated likewise, while the lateral lamellæ, being blind sacs, now show as more or less circular pits. In the case of those preserved in ironstone nodules, they have been deposited in mud in a similar manner to that already described, but before the pressure was sufficient to bring about the collapse, the body of the animal has acted as a nucleus, round which the saline waters have deposited the iron and lime carbonates, and the grains of mud having been thus cemented together into a firm consistency, the remains of the animal have been protected and preserved in the round. Excellent examples of both effects are seen where fish have been partially enveloped in nodules. The portions within the nodules stand out in relief, while those parts which extend into the ordinary shales beyond are pressed flat. The otoliths of the fish appear to act as the nuclei, round which salts of iron and lime gather, or in many cases to have afforded the lime carbonate which has formed a nodule

round the head only of the fish, so that it is generally that portion which is preserved in the round.

There is a special interest attaching to these Lower Old Red myriapods which would appear to be the oldest land animals yet known, or, at least, described. They occur along with Eucephalaspis at that place made classic by the writings of Hugh Miller and others—"Balruddery Den"—in Forfarshire, and were in all probability alive when many Upper Silurian forms of animals and plants were still extant. In another matter they bear some slight evidence as to the conditions under which the Lower Old Red sandstone was deposited, as they point to proximity to land, and give countenance to the theory, otherwise well supported, of that formation having been laid down in an inland sea or lake. Plants are found associated with the specimens in nearly every case, and one specimen belonging to Mr Powrie, on which the remains of four or five different individuals are seen on the exposed surface, is nearly black with fragments of land plants.

To the biologist they are interesting, for they are simpler in construction than any other described Chilognaths. The body segments are all free, and each bears but one pair of legs, a condition of things which is only to be found in the larvæ of their recent congeners. In this they are very unlike the Carboniferous genera, which depart more widely from larval forms than do recent adults, a circumstance which appeared to Scudder, who did not know of these older forms, to be anomalous and inexplicable.*

The wide sternal plates of the Old Red myriapods link them on to the Carboniferous genera, and the broad lateral forked spines of *Euphoberia armigera* and *E. ferox* may be looked on as the homologues of the lateral lamellæ of Archidesmus. Our recent *Craspedcsoma Raulinsii* has its lateral lamellæ set with two strong spines or bristles at their posterior angles, much as in *Euphoberia* (Pl. II., fig. 3). No trace of frustra, such as occur in *Xylobius*, have been observed, nor any *foramina repugnatoria*. The former could

* See Scudder on Myriapods of the genus *Euphoberia* (Meek and Worthen) —*American Jour. of Science*, vol. xxi., p. 186.

scarcely occur without being seen, while the latter might easily be present and escape detection.

Literature relating to Palæozoic Myriapods.

Dawson.—*Xylobius Sigillariæ* (Dawson). *Quart. Jour. Geol. Soc.*, London, 1859, vol. xvi., pp. 268-273, figs. 4-9.

Meek and Worthen.—*Euphoberia.* Geol. Surv. Mem. Illinois and Iowa, vol. iii., pp. 556-559.

Scudder.—*Xylobius* and *Archiulus. Memoirs of Boston Nat. Hist. Soc.*, 1873, vol. ii., pt. ii., No. 3. Figs. given in supplementary note read October 20, 1875.

Scudder.—*Euphoberia.* The structure and affinities of *Euphoberia* (Meek and Worthen), a genus of Carboniferous myriapods. *American Jour. of Science*, vol. xxi., March 1881, pp. 182-186.

Woodward.—*Xylobius.* On a Chilognathous myriapod from the Coal Measures of the West of Scotland. *Trans. Geol. Soc.*, Glasgow, vol. ii., p. 234.

Woodward.—*Euphoberia. Geol. Mag.*, 1871, vol. viii., pp. 102-104.

Explanation of Plate.

Fig. 1. *Kampecaris Forfarensis* (Page).—Mag. four diameters. From Turin Hill, Forfarshire. Specimen belonging to C. W. Peach.

Fig. 1*a*. Left eye of above magnified still more.

Fig. 1*b*. *Kampecaris Forfarensis.*—Natural size. From specimen belonging to Watt Institute, Dundee.

Fig. 1*c*. Outline of 1*b* magnified.

Fig. 1*d*. *Kampecaris Forfarensis.*—Natural size. From specimen obtained from Canterland, Kincardineshire, by David Page, and presented to James Powrie, Esq., Reswallie, Forfarshire.

Fig. 1*e*. *Kampecaris Forfarensis.*—Natural size. From specimen preserved in the round, and presented by Sir Philip Egerton to Jermyn Street collection. Locality—Balruddery, Forfarshire.

Fig. 1*f*. Same as 1*e*. Diagrammatic outline to show articulation of the alternate larger and smaller segments.

Fig. 1*g*. Diagram of larger and smaller segments of *Kampecaris Forfarensis*, with their appendages to compare with fig. 3*a*.

Fig. 2. *Archidesmus Macnicoli*, nov. spec.—Natural size. From specimen presented to C. W. Peach by Walter MacNicol, Esq., Tealing, near Dundee. Locality—Carmyllie, near Arbroath, Forfarshire.

Fig. 2*a*. Portion of above magnified.

Fig. 2*b*. *Archidesmus Macnicoli.*—Natural size. From specimen belonging to James Powrie, Esq.

Fig. 2*c*. Diagram of larger and smaller segments of *Archidesmus Macnicoli*, to compare with fig. 3*a*.

Fig. 2*d*. Leg of fig. 2 magnified to show spines at the articulations.

Fig. 3. *Craspedesoma Raulinsii.*—Recent, from Queen's Park, Edinburgh, for comparison.

Fig. 3*a*. Diagrammatic double segment of Craspedesoma to compare with figs. 1*g* and 2*c*.

Fig. 4. *Iulus Blainvillii* to compare with fig. 1*c*. Copied from figure in Gervais' "*Insectes Aptères.*"

X. *Additional Notes on the Algæ of the Firth of Forth.* By GEORGE WILLIAM TRAILL, Esq. (Communicated by Professor DUNS.)

(Read 18th January 1882.)

List of fourteen species new to the Firth of Forth, discovered by G. W. Traill during the year 1881, including several which are new to Britain; with exhibition of specimens.

1. *Cladophora centralis*, Lyng.—A new *Cladophora* found sparingly at Joppa, in muddy pools, near high water, identified by Mrs Merrifield as the *Cladophora centralis* of Lyngbye, and new to Britain.
2. *Rhizoclonium riparium.*—Caroline Park and Joppa rocks, parasitical on algæ.
3. *Urospora pencilliformis*, Areschoug.—Not uncommon at many places in the Firth of Forth, such as Earlsferry, Kinghorn, Burntisland, Inchcolm, Granton, very fine; Joppa, Fisherrow Pier, North Berwick, Broxmouth, always associated with *Ulothrix flacca;* on rocks, and sometimes on fuci, near high water; perennial, fruiting in winter. Found also by Mr Holmes at Ventnor in March 1880, and then new to Britain.
4. *Cladostephus distichus*, Holmes.—The plants found by me at Kincraig in 1879, and considered to be a ariety of *Chætopteris plumosa*, with some- rent branching, Mr Holmes now forms

into a distinct species, and gives it the name *Cladostephus distichus*. Mr Holmes, in a paper recently read before the Royal Microscopical Society of London, has pointed out that this plant is distinguished by bearing both the *plurilocular* and *unilocular sporangia* in minute special branches, which form a short down surrounding the main branches, as in *Cladostephus*, while the typical *Chætopteris plumosa* bears *sporangia* on the ordinary *ramuli* and not on the axis.

5. *Dictyosiphon fœniculaceus*, sub-species *flaccidus*, Areschoug.—In muddy pools, at about half tide, North Berwick; parasitical on *Phlœospora tortilis*, August 1881; new to Britain.
6. *Phlœospora tortilis*, Areschoug.—In muddy pools, at about half tide; Joppa, May 1880; Pettycur near Kinghorn, Elie, and North Berwick, 1881. Annual, March to August, inclusive.
7. *Ectocarpus longifructus*.—Dunbar, in pools at half tide; rare.
8. *Callithamnion byssoideum*.—Elie, on rocks at half tide; rare.
9. *Callithamnion mesocarpum*.—Joppa, on muddy rocks at very low tides.
10. *Phyllophora* (new species).—Joppa, near Granton quarry, etc., on rocks at very low tides; often accompanying *Sphacelaria radicans* and *Chætopteris plumosa*, 1880. Perennial, fruiting in winter; new to Britain.
11. *Polysiphonia thuyoides*.—Broxmouth, near Dunbar, 1880; rare.
12. *Cordylecladia erecta*.—Joppa, at very low tides, growing half immersed in sand; rare.
13. *Dermocarpa prasina*, Bornet.—Parasitical on *Catenella opuntia* at Caroline Park rocks, 8th Jan. 1881; Longniddry and Lady's Tower, Elie. Found originally by Mr Cresswell at Teignmouth in Jan. 1880, parasitical on *Callithamnion Rothii*, when new to Britain.

14. *Halidrys siliquosa*, permanent variety.—There is so distinct a line of demarcation between this slender feathery variety and the typical form of *Halidrys siliquosa*, that our British authorities who have examined the specimens consider it ought to rank as a sub-species. It has hitherto been found only at Broxmouth, near Dunbar, in pools near low water, associated with typical *Halidrys siliquosa*, but never passing into it.

XI. *An Addition to the Fish Fauna of the Oil Shales of Edinburghshire.* By JOHN GIBSON, Esq.

(Read 18th January 1882.)

The extensive scale on which the bituminous shales of Edinburgh and Linlithgow shires have of late years been worked in connection with the paraffin industry, has afforded the palæontologist an opportunity of becoming acquainted with the life of the period to which they belong. The oil shale itself is, as a rule, singularly destitute of fossils. Associated with it, however, is a non-bituminous shale known to the miners as "blaes," and which is more or less thickly studded with ironstone balls or nodules. Industrially worthless, this material is scientifically valuable on account of the fossils embedded in it. Plants are specially abundant in the shale, but, so far as my experience goes, the fish remains are confined to the ironstone nodules. There is little doubt, however, that they occur in the shale as well; only having once found fish remains in the nodules, the collector is apt to confine his attention to these to the neglect of the other. Recently I found this to be the case with another non-bituminous nodular shale, namely, that occurring along the shore at Wardie. Fish remains have been collected from that locality persistently for half a century, but in all cases, so far as I have been able to learn, they have been obtained only from the ironstone nodules, the shale having yielded nothing ichthyic beyond a few detached scales. When collecting recently at Newhaven, for want of nodules to operate upon, I took to splitting detached water-worn pieces of the

shale, and had the satisfaction of uncovering a remarkably well-preserved specimen of a fossil fish, the scales of the body and the fins being seen in their natural position. Unfortunately, however, the piece containing the head had been broken off before the bit of water-worn shale fell into my hands. The fish (specimen exhibited) belongs to the genus *Elonichthys*, and, so far as can be judged in the absence of the head, the species is closely allied to, if not identical with, *E. Dunsii* (Traq.). I have since obtained other specimens of fossil fishes from the same shale.

Among the many ichthyic remains which have from time to time rewarded my search among the "blaes" heaps of the oil district, several of which were noticed by Dr Traquair in a paper read before this Society, the first place in point of rarity, and possibly also of scientific interest, belongs to a specimen of *Ctenodus*, found at one of the shale pits near West Calder, which forms more especially the subject of the present notice.

Ctenodus, so far as yet known, is a wholly Carboniferous genus, while the records of its occurrence in strata older than the coal measures are exceedingly few. Dr Traquair, in a paper published in the *Geological Magazine* on "Fish Remains from the Blackband Ironstone of Borough Lee,"—a portion of the Carboniferous Limestone Series—described a new species (*C. angustatus*) possessing exceedingly minute palatal teeth. He also noticed a fragmentary tooth of a larger size from the same locality. With regard to its occurrence in the lowest division of the Carboniferous system, namely, the Calciferous Sandstone Series, Professor Agassiz gave the name *C. Robertsoni* to a tooth from Burdiehouse, but, as he did not describe it, and as the specimen is lost, it is impossible to determine its specific identity. The notice of this species is only interesting, therefore, as the first record of the occurrence of *Ctenodus* in rocks of Calciferous Sandstone age. In a paper read before the Geological Society of London, in June 1880, by Mr Kirkby, on the "Zones of Marine Fossils in the Calciferous Sandstone Series of Fifeshire," the author states that at 2120 feet below the Carboniferous limestone, *Ctenodus* sp. occurred;

what these remains were Mr Kirkby does not state. The specimen I now show is, therefore, the third recorded instance of the occurrence of *Ctenodus* in rocks belonging to the Calciferous Sandstone Series, and the first of its occurrence in the oil shales of this district. The specimen shows a single tooth, only part of which, however, is visible; the remainder is so imbedded in the ironstone as to offer little hope of separating the two. It will be possible, however, to remove the tooth by means of acid, and from the mould thus left to obtain a cast of the remainder of the tooth. From the part visible, the tooth appears to have nine ridges moderately tuberculated throughout, the ridges growing deeper and further apart as they approach the outer margin. Associated with the tooth are several bones of the head occupying their natural position. Similar specimens have been found in the coal measures of Northumberland, but they are decidedly rare. This specimen also shows the greater part of the operculum of the fish—a roundish, thickened bone measuring about 4 inches across. From data supplied by a very small but tolerably complete specimen of *Ctenodus*, described by Mr Atthey, the individual to which the large operculum belonged, was probably not less than five feet in length. *Ctenodus* possessed well ossified ribs, and in the present specimen several portions of ribs are to be found. One of these is of special interest, as showing where a rib has been fractured, and afterwards repaired in the living fish. That the *Ctenodus* to which this tooth and these bones appertained was not specifically identical with any of the coal measure forms is almost certain, and when the entire tooth is visible it may be expected to disclose characters sufficient to distinguish it from previously described species. As the head bones, however, belong presumably to the same fish as the tooth, and as the unravelling of the complex relationships of these could only be attempted satisfactorily by a specialist in fossil fishes, I do not propose affixing a specific name to those remains, but will leave their further description to Dr Traquair, who is at present collecting material for what will, no doubt, form a satisfactory treatment of the genus *Ctenodus*.

XII. *A Preliminary List of Scottish Myriapoda.* By T. D. GIBSON CARMICHAEL, Esq.

(Read 15th February 1882.)

In Loudon's "Magazine of Natural History," vol. viii. for 1835, there is a paper by George Johnstone, M.D., F.R.C.S.E., entitled "A Catalogue of the Insecta Myriapoda found in Berwickshire." This paper is peculiarly interesting, because after a lapse of almost half a century it still remains the only attempt at a list of the Scottish species of Myriapoda. Johnstone mentions eleven species as being found in Berwickshire, and, with the exception of two (*Craspedosoma Rawlinsii* and *Geophilus subterraneus*), he states that they are all common. His list gives the following species :—

Glomeris marginata (Leach).
Iulus sabulosus (Linn.).
„ *niger* (Leach).
„ *punctatus* (Leach).
„ *pulchellus* (Leach).
Craspedosoma Rawlinsii (Leach).
Polydesmus complanatus (Linn.).
Lithobius vulgaris (Leach).
Geophilus subterraneus (Leach).
„ *acuminatus* (Leach).
„ *longicornis* (Leach).

Of *I. pulchellus* he recognises two varieties, one corresponding with *I. candidus* of Muller,* *I. pulchellus* (Leach), and *I. fragarium* (Lamarck); the other variety corresponds, Johnstone thinks, to *I. tuberculosus* (Muller).†

The object of the present paper is to give a list of the species known to the writer as inhabiting Scotland, comparing them with Johnstone's list. This list must be far from complete, as a collection has only been made in a few localities, and during few months.

The species are—

1. *Iulus Londinensis* (Leach).—Of this species I found

* Zool. Dan., Prod. 201, n. 2425.

† *Ibid.*, n. 2424.

two specimens under a stone near the Luce, in Wigtownshire; and I think that had I examined all my material, I should probably have found that it occurs in other places.

2. *Iulus pusillus*, Leach (*boleti Am Stein, boleti* v. *Porath*).—Abundant in moss-decaying tree stumps, etc., in Peeblesshire, Selkirkshire, Wigtownshire, Midlothian, and probably throughout the whole of Scotland, as I took specimens in Kinross-shire, near Oban, and on the Ness Islands at Inverness.

3. *Iulus sabulosus.*—I have found this species common in damp localities, under stones and fallen logs, in Peeblesshire and Wigtownshire. A few specimens were found by me at Oban. Johnstone gives it as frequent in Berwickshire, and it probably occurs in all the low lying districts in Scotland.

4. *Iulus silvarum*, Meinert (*Danmarks Chilognathes*).—This species I have taken abundantly in woods in Peeblesshire. I have also found it near Edinburgh.

5. *Iulus punctatus* (Leach).—This is perhaps the most common and most widely distributed Iulus in Scotland. I have found it wherever I have collected. Johnstone gives it as common.

6. *Iulus terrestris*, Linn. (*I. niger*, Leach).—Common everywhere. This species is very fond of fallen logs of Scotch fir, and is to be found at a fairly high level above the sea. Scotch specimens appear to be blacker than English.

7 *Blaniulus guttulatus* (Fabr.).—This seems to be Leach's *Iulus pulchellus*, which Johnstone states to be abundant in Berwickshire. I have found it in abundance in Peeblesshire, Wigtownshire, and Midlothian.

8. *Polydesmus complanatus.*—This is common wherever I have looked for it, though not apparently at high altitudes.

9. *Craspedosoma Rawlinsii.*—I have not myself met with this chilognath; but Mr Gibson has procured

for me specimens from the neighbourhood of Edinburgh, the locality from which Leach first obtained his types. Johnstone gives it as rare in Berwickshire. I fancy that localities near the sea are most favourable for this species.

10. *Glomeris limbata*, Latr. (*G. marginata*, Leach).—Since beginning the study of Myriapoda, I have not taken this species in Scotland, but I remember seeing it in large numbers near Newton Stewart, and generally throughout Galloway. Johnstone says it is common in Berwickshire. And I hear from Mr Gibson that it is to be found on Arthur's Seat.
11. *Polyxenus lagurus*.—I have found a few specimens of this in Peeblesshire.
12. *Lithobius forficatus*, Linn. (*L. vulgaris*, Leach).—Common everywhere in low grounds.
13. *Lithobius borealis* (Meinert).—A species answering I think to this, is to be found abundantly throughout Scotland, especially at considerable altitudes.
14. *Himantarium subterraneum*.—Common through south and probably through whole of Scotland. Johnstone says of it "in gardens rather rare," but probably he did not find it as common as it is, owing to its habit of living hidden away in earth.
15. *Scolioplanes acuminatus*.—This I have found common near St Andrews. Johnstone found it especially common near the sea shore in Berwickshire.
16. *Geophilus sodalis* (Meinert).—Common under stones in Peeblesshire in fields, and on bare hillsides to an altitude of upwards of 2000 feet.
17. *Geophilus longicornis*.—Frequent in south of Scotland and near Oban.
18. *Geophilus electricus* (Linn.).—A few specimens from Peeblesshire.

I have thus found during the summer, seventeen species, and know of one more species of Myriapoda which inhabit Scotland. I have no doubt that by next winter more careful collecting will bring to light quite as many again.

The Myriapoda are a group which, from genetic considerations, are particularly well worth studying, and which in this country have been particularly neglected. There are many points in their anatomy which require clearing up. It is much to be hoped that some Scotch naturalists may take up this branch, and that before this year is finished we may be able to furnish a more complete list of Scottish Myriapoda.

NOTE.—Information is particularly needed as to altitude attained by species, and breeding habits.

XIII. *Note on the Occurrence of the Tree Sparrow in Argyllshire, and its Distribution in Scotland.* By JOHN JAMES DALGLEISH, Esq., M.B.O.U.

(Read 15th February 1882.)

The tree sparrow (*Passer montanus*) is a species of very wide distribution, being found throughout Europe, Northern Africa, and the greater part of Asia, as far east even as China and Japan,* and towards the south as far as Afghanistan and the Himalayas, and down through Burmah to the island of Java. It also occurs in the Philippine Islands. It seems, however, to be more partial to northern regions, being more numerous throughout Northern Russia, where Mr Harvie-Brown found it plentiful in the smaller villages, and Siberia, than in more southern countries. In the Faröe Islands, where, according to Captain Fielden, a few pairs arrived for the first time only a few years ago, the species has increased to such an extent as to have become quite a pest. It is said to have been accidentally introduced into St Louis in the United States.

Having lately discovered a colony of this bird in Argyllshire, the occurrence of which it seemed desirable to bring before the notice of the society, the opportunity seemed a favourable one for reviewing and bringing up to date the record of its distribution throughout Scotland. From its great similarity, in general appearance, to its ally the common house sparrow, it has been, doubtless, frequently overlooked,

* Proc. Roy. Phys. Soc., iv., p. 148.

and therefore it may not be altogether superfluous should I, in the first place, in a few words, recapitulate the chief points of difference between them, which has already been done on a former occasion by our late Secretary, Dr J. A. Smith.* These, then, are briefly the rather smaller size, and the chestnut-brown colour of the crown, nape, and hind neck of the tree sparrow, of both sexes, which are nearly alike, as contrasted with the ashy-grey colour of the same parts, in the male house sparrow (as you will observe from the specimens before you), the presence of two distinct bands of white across the wing of the former, one of which is wanting in the latter, and also the presence of a large black patch on the side of the head below the ear, which is awanting in the more familiar species. In the general colouring of the other parts, the two species are very similar.

In England, it is general, though local in its distribution, and seems to have been more frequently observed in the eastern and north-eastern counties than in those on the western side of the island. Dresser, however, mentions its occurrence in Dorset and Somerset. In no part of Great Britain does it seem to inhabit towns, with the single exception, perhaps, of Berwick-on-Tweed, as after mentioned.

In Scotland, to which the present notes are more particularly confined, it is only of comparatively recent years that it seems to have been observed; neither Macgillivray nor Sir William Jardine having, at the date of the publication of their respective works on "British Birds," known of its existence on this side of the border. According to Mr Gray, the first notice of its occurrence in Scotland was given by Mr Don, who has recorded it from the mountains of Forfarshire; and somewhat later, a specimen shot in Caithness was observed by Mr James Wilson in the collection of Dr Sinclair, of Wick, and mentioned by the former, in his voyage round the coasts of Scotland. Since then, the tree sparrow has been noticed in several other parts of Scotland, and has quite established its claim as a Scottish species. Mr Osborne, of Wick, has, as recorded in our *Proceedings*,† again seen it near that town; and Mr Charles St John, in his pleasant volume, "Natural

* Proc. Roy. Phys. Soc., ii., p. 69. † *Ibid.*, ii., p. 338.

History and Sport in Moray," mentions his having found it breeding, and by no means uncommon, near Elgin, where he for some time resided. The Rev. Dr Gordon, of Birnie, also informs me, that he has notes of its occurrence at Main in 1838, and Waulkmill in 1844, both near Elgin, and mentions Waterford on the west, and Cassieford on the east, of Forres, as localities where it has also been observed. In 1872, Sheriff Mackenzie, now of Tain, discovered a small colony of this species breeding at Dornoch, in Sutherland, and obtained several clutches of their eggs; but he has just written me, that since that date they have quite disappeared from that locality. He, however, in September 1875, saw a single specimen at Strathpeffer, in the county of Cromarty, where he thinks it may probably be found breeding. He also mentions having, so long ago as the spring of 1847, shot a specimen in the neighbourhood of Aberdeen, and presented it to Professor Macgillivray, whose natural history class he was then attending, and who pronounced it to have been the first specimen known to him as having been got in Scotland. Neither of my correspondents, Mr Sim or Mr Beveridge, of Aberdeen, however, have known of its occurrence there in recent years. The Rev. Dr Joass, of Golspie, informs me that he once observed the tree sparrow near his house there in the breeding season, but failed to find the nest. From the Rev. Mr Stewart, of Nether Lochaber, I learn, through Mr Harvie-Brown, that he some years ago met with five individuals of this species in Strathardle, Perthshire, about two miles north of Bridge of Cally, feeding on the road side, and heard of it being still a summer visitant there some time afterwards. He has not seen them on the west coast. Mr James Keddie, assistant to Mr Sanderson, one of our local naturalists, tells me, that the tree sparrow is found in small numbers at St Michael's Wood, near Leuchars, Fifeshire.

Perhaps the district in which it has hitherto been best known is that of East Lothian, more particularly in the neighbourhood of North Berwick, where it was first discovered many years ago, by the late John Nelson on the farm of Castleton, since which time, as Mr Gray has informed us, it has been observed on several other farms in the same

neighbourhood, all within a limited radius of ten or fifteen miles. A specimen shot at Pitcox, near Dunbar, in the same county, by the late Dr C. Nelson, was exhibited at a meeting of this Society in 1859.

From Mr George Bolam, of Berwick-on-Tweed, I have received a most interesting account of the tree sparrow's appearance and habits in Berwickshire. He states that "it is fairly common all along the coast-line of North Northumberland and Berwickshire, and, wherever suitable breeding places exist, may be found in considerable numbers. It does not appear to venture far from the coast, however, and so far as I am aware, except as a mere straggler, is not found in this district more than a few (say six or eight) miles inland." He has observed it at Reston station on the North British Railway in Berwickshire. He further adds that, although partially migratory, it is found in that district throughout the year, being most plentiful in summer.

In Ayrshire, the tree sparrow was found breeding in 1870 by the late Mr John Jameson, of Ardrossan, under the cope of a wall near that town, and a specimen from that locality was exhibited by Mr Gray at a meeting of the Natural History Society of Glasgow in the same year. The latter gentleman states, in his work on the "Birds of the West of Scotland," that Mr D. C. Brown, of Glasgow, informed him that he had observed it in limited numbers at Arrochar, on Loch Long; but Mr Lumsden, of Arden, who resides in that neighbourhood, and to whom I applied, is unable to add any late information as to this locality. Mr George Black, of Greenock, tells me that a pair were seen at Cothouse, near Kilmun, a few years ago, by Mr Thomas Struthers, now Curator of the Greenock Museum; and it is believed to breed in that neighbourhood.

I am not aware that this bird has been observed on the west coast, to the north of the Clyde, until the last two summers, when I have been fortunate enough to find it, to the number of possibly twenty pairs, at Kilchoan, in the western end of Ardnamurchan, in north-west Argyllshire, opposite Tobermory, in the island of Mull. I was first struck by their smaller and neater appearance, and habits less

bustling than those of the house sparrow, and further observation led to the discovery of their identity. First observed in August 1880, they were then going in a flock on the cultivated land near the houses, in company with linnets and chaffinches. Last summer, however, I again found them in the same locality, but in the breeding season, in the month of June. They seemed not nearly so noisy, or obtrusive in their habits as the more familiar species, spending [most of their time on the ground, and at the breeding time frequenting the potato patches, whence they flew backwards and forwards, in the manner of starlings, with food for their mates or young. They fly at a lower elevation than the common sparrow.

The last locality from which I have any record is Loch Aline, in the district of Morven, a little way to the south of Ardnamurchan, where Mr Black observed a pair of young birds last autumn in a clump of birch and hazel not far from the loch.

With regard to their nesting habits, my own observation confirms that of others, that their choice of a position for the nest varies. I took one nest from a hole in the walls of the ruined old church of Kilchoan, and two or three others I observed were in the thatch of the crofters' houses, just above the wall. The materials were similar to those used by the house sparrow—straws and abundance of feathers. Mr Scot-Skirving informs me, that at his former residence in East Lothian, they built their nests in corn stacks. Mr Bolam writes: " In Berwick it breeds in holes in the town walls, in company with house sparrows and starlings; and a little further to the north, and again at St Abb's Head, I have found its nest in the sea banks, sometimes amongst the rocks, and sometimes in sandy banks in holes, at one time very possibly used by sand-martens, or at all events in every way similar to them. At Holy Island and several other places in Northumberland, it regularly breeds in old lime kilns (both used and disused), and I have not unfrequently seen nests under the tiles of the roofs of buildings and empty cottages, as also in holes in the walls of the same. In such situations it has always struck me, that its nests were more

carefully put together than those of the common species, and no long straws, etc., left hanging down from the bottom, or protruding from the hole which formed the entrance to the nest, nor is so large a quantity of materials used as is generally found in the nest of the common sparrow." It occasionally breeds in holes in trees, especially in England, whence probably the somewhat misleading name of tree sparrow. Professor Newton says, that in the last-mentioned country it is perhaps most frequently found breeding in the rows of pollard willows, which are so common on the banks of many of the rivers and canals there, and where it easily excavates in the rotten wood a receptacle for its nest. He also mentions, that in some countries it occasionally builds in a deserted crow's or magpie's nest, and in Sicily has even been known to rear its young in the foundations of an eagle's nest, which at the same time was tenanted by the owners, a circumstance not uncommon in the case of an allied species—*Passer salicicolus*, the Spanish sparrow. A recent writer, Lieutenant-Colonel Swinhoe, in describing his observations on the birds seen by him during the late campaign in Afghanistan, mentions, that although the tree sparrow, which is the commonest species in Kandahar and the country generally, is often found building in the same roof with *P. domesticus*, it does not associate with it, and never loses an opportunity of attacking it, and, in consequence, the latter takes care to keep out of its way.

The eggs are similar in colour to those of the house sparrow, but smaller in size, and of a darker shade of grey, although occasionally light ones are to be found in a clutch.

Unlike the house sparrow it migrates, at all events to some extent, in winter, in which season they almost entirely leave Ardnamurchan, and possibly the pair above recorded as having been seen at Loch Aline was on migration when observed. On the east coast of England great numbers assemble in the autumn, probably on migration south. Mr Cordeaux mentions having seen as many as five or six hundred together, and an instance is recorded in the "Zoologist" (p. 7312) of thousands having boarded a light-ship off the Dogger Bank in November 1860.

In conclusion, I would only express a hope, that this note on a little known, but possibly not very rare, species, may be the means of calling the attention of others to it, and thereby of adding to our knowledge of its habits and distribution in Scotland.

XIV. *Exhibition of Nests and Eggs of Shoveller Duck* (Spatula clypeata) *and Scaup Duck* (Fuligula marila) *from Fifeshire, and Nest and Eggs of the Goosander* (Mergus merganser) *from Sutherlandshire.* By ARTHUR C. STARK, Esq.

(Read 15th February 1882.)

The nest (with nine eggs) of the shoveller (*Spatula clypeata*), exhibited, was taken by myself on the 16th of May 1880. It was built in a marshy spot by the side of a retired loch. I found it accidentally, the female starting up just in front of me as I was walking round the loch. The bird looked so small that at first I thought it was a teal, but as she fluttered about feigning lameness within a few yards of me, and finally stood still about 20 yards off, I had ample opportunity of correcting my first impression, and of seeing that the bird was a female shoveller. On examining the spot from whence the duck had risen, I found a nest, containing eight eggs, placed in a hollow in the centre of a large tuft of dry grass which almost completely concealed it. Before taking the nest I twice allowed the old bird to return that I might have an opportunity of closely observing her through my binoculars. After making quite sure that I could not be mistaken I took the nest and eggs. On lifting the nest out of the hollow that contained it, I found another egg lying on the ground below. The nest measured, *in sitû*, 7 inches across by 6 inches deep, and was built of dry grass and straws profusely lined with the down of the bird. The eggs were within a few days of hatching, and from one of them I succeeded in extracting the embryo in a state of entirety. I may men[illegible] saw both male and female shovell[illegible] to the 6th of

June following, and I have good reason to believe that they built another nest within a few yards of the one I took.

The nest and eggs of the scaup duck (*Fuligula marila*), shown, are from the same locality as the shoveller's nest. For some reason, considerable numbers of scaup ducks remained on the loch during the summer of 1880.

On the 15th of May I saw forty, all paired. On the 20th of the same month I counted eleven males and ten females; a week later there were still ten pairs on the loch. On June 5th, I saw five pairs, and on the following day I started a female scaup from her nest. This was placed in an isolated clump of rushes close to the side of the loch, and contained eleven fresh eggs. It was built of dead rushes, and was lined with a large quantity of down. The old bird after leaving the nest pitched in the water about a gunshot off, and gave me a good opportunity of examining her through a telescope. I can find no previous record of this duck having bred in Britain.

The goosander's nest (with the female bird) was taken in West Sutherland by myself on the 10th of May 1878. While fishing on a loch I noticed a male goosander fly past our boat, and pitch in the water close to the edge of a birch wood that clothed a steep and broken hillside. The male was shortly afterwards joined by a female, and judging from their movements that they had a nest not far off, I landed with the boatman and proceeded to search the wood. We found, however, that the trees were too small to accommodate a goosander with a hole large enough to contain its nest, and we had abandoned the search and were on our way back to the boat, when I happened to put my foot on the limb of a birch tree that grew on the verge of a low cliff, and to my astonishment out came a female goosander apparently from the ground. On examination, however, we found a deep hole running between the roots of the birch and the surface of the rock, and about 18 inches from the entrance was a nest of white down containing twelve eggs. We left the nest for a time, and returning about dusk secured the female, by throwing a plaid over the hole.

XV. *On some recent Contributions to our Knowledge of the Morphology and Physiology of the Cell.* By PATRICK GEDDES, F.R.S.E., Lecturer on Zoology in the School of Medicine, and Demonstrator of Botany in the University of Edinburgh. [Plate III.]

(Read 1st March 1881, with additions 15th March 1882.)

After the establishment of the cell theory, and more especially after Max Schultze had shown that the cell was not of necessity definitely walled, but was essentially a naked lump of protoplasm with an embedded nucleus, the attention of histologists was for some years almost withdrawn from the scrutiny of the minute structure of this unit-mass, to be concentrated upon the study of the modes of arrangement and differentiation of these unit-masses into the systems of tissues into which the genius of Bichât had analysed the organism. With the discovery of the remarkable changes which are to be observed in dividing cells, however, a return from the study of the cell-aggregate to that of the cell itself commenced, and this newer movement has been so fruitful and so suggestive that the question of cell structure is again paramount in histology. It is the object of the present paper briefly to summarise and discuss some of the later contributions—excepting, however, those relating to the changes which go on during cell-division—partly because the enormous and rapidly increasing literature on this subject is already admirably treated in the well-known works of Flemming, Strasburger, and others, which excellent summaries have been from time to time published in English,* but also because the rapid increase of our knowledge of the wonderful phenomena exhibited by the dividing nucleus has naturally tended to throw into the shade numerous other scarcely less important lines of research which may profitably be considered.

Assuming, then, a knowledge of at least the ultimate result of these researches—the fundamental similarity of the process of cell-division in animal and vegetable (

* Quart. Journ. Micro. Sci., xvi., xviii., xx., etc Micro. Soc. Lond., *passim.*

let us consider what steps have been taken towards the solution of the numerous cognate inquiries.

1. Is a nucleus universally present? The group Monera was erected by Hæckel* in 1868 for the reception of the numerous very simple protoplasmic organisms in which no nucleus had been detected, and in which he assumed none to exist. The discovery of a distinct nucleus in Foraminifera by F. E. Schultze† and Richard Hertwig‡ cast serious doubts upon the distinctness of the group, so that Claus § and others have proposed its entire abandonment. Among plants, too, a vast number of the lower algæ and fungi, formerly considered destitute of nuclei, have been shown always to possess one or even many, so that Schmitz holds that Thallophytes destitute of a nucleus are altogether unknown.‖ The Bacteria, however, still remain, and although a re-examination of such forms as *Protomyxa* is very desirable, it seems more probable that there really exist certain low forms in which the protoplasm may be non-nucleated.

2. Passing over the numerous investigations as to the internal structure of the nucleus, it may be noted that Macfarlane ¶ has recently drawn attention to a minute spheroidal body commonly present within the nucleolus, which, though occasionally figured, has never been thought of any importance. He terms this the endo-nucleolus; and in later papers he points out the great constancy of its occurrence in both animal and vegetable cells, and asserts that the division of the cell starts from this innermost body, which divides before the nucleolus and this before the nucleus.

3. Great attention has recently been paid to multinucleate cells. Schmitz** found numerous nuclei in Siphonocladaceæ, etc. Maupas†† counts as many as from 150 to

* Monographie Moneren. Jena Zeitschr., iv., 1868.

† Rhizopoden Studien. Archiv. f. Mikrosk. Anat., i.

‡ Bemerk. z. Organ. u. systemat. Stellung d. Foram. Jena Zeitschr., x., 1876.

§ Lehrbuch d. Zoologie. 4te Auflage, Wien, 1880.

‖ Journ. Roy. Micro. Sci., 1880, p. 482.

¶ Trans. Bot. Soc. Edin., 1880.

** *Op. cit.*

†† Journ. Roy. Micro. Sci., 1880, p. 106.

200 nuclei in tubes of *Cladophora*, many also in *Vaucheria*, *Empusa*, and Infusorians. Hegelmaier* finds multinucleate cells in the suspensor of Dicotyledons; and Treub,† whose researches are earliest and most elaborate of all, has proved the plurality of nuclei of constant occurrence in the vegetative cells of phanerogams, especially in the laticiferous cells and bast fibres of *Euphorbia*, *Vinca*, etc. All the nuclei in one cell sometimes divide simultaneously, division just stopping short of the formation of septa. Considerable light has also been thrown on the multinucleate condition by the recent observations of Macfarlane on the development of *Chara*.‡ He finds that the internodal cells partially keep pace with the division of the nodal cells, their nucleolus first dividing repeatedly, and the multinucleolate nucleus then breaking up into many portions. In the nodal cells the nucleolus also proliferates when division ceases, and the nucleus may break up.

The multinucleate condition thus loses much of its apparently anomalous character, and seems to be readily assumed by large cells, such as giant cells, in which abundant nutrition continues after maturity. A special term—such as *syncytium*, proposed by Gegenbaur—seems unnecessary.

4. The generalisation *Omnis cellula e cellula* being accepted, are we also to admit the similar maxim, *Omnis nucleus e nucleo?* In the majority of cases this is, of course, true; but do no exceptions occur—is free nucleus formation in protoplasm impossible? In this relation, while by no means intending to commit myself unreservedly to the maintenance of that (on the whole less probable) view, I am desirous of calling the attention of other investigators to two cases already described and figured by myself, which appear decidedly to support it. The first case was observed in a species of *Enteromorpha* § (see fig. 2), in which the new cells

* Journ. Roy, Micro. Sci., 1880, p. 979.

† Niederland Archiv., 1879.

‡ Trans. Roy. Soc. Edin., 1882

§ On the Phenomena of Variegation and Cell Multiplication in a species of *Enteromorpha* (Trans. Roy. Soc. Edin., 1879-80).

arising by the process which I have termed *interlaminar gemmation* appeared at first perfectly homogeneous, never exhibiting a nucleus, even on treatment with reagents, while the older and larger ones possessed a distinct nucleus and nucleolus. Secondly, in the even more remarkable case of endogenous cell formation presented by the brown corpuscles of *Echinus* * (fig. 1), no nucleus is distinguishable until the adult corpuscle has reached its full development. Such cases as these demand careful reinvestigation, before the invariable origin of nuclei from pre-existing nuclei can be safely maintained.

5. Passing now from the morphological aspects of the nucleus to the physiological, the older view—of the nucleus as a mere inert dense lump—need not detain us. Not only do the wide chemical differences between the nucleus and the surrounding protoplasm oppose this view, while the phenomena of all multiplication tend to show that it is, on the contrary, the seat of the activities of the cell, but it is sometimes possible even to observe its movements. The nucleus of many ova is capable of amœboid movement; † Unger ‡ has observed similar movements both in normal and in inflamed tissues. Schleicher § describes an easy method of watching the movements of the nucleus in the living cartilage cells of the frog's omosternum, and I ‖ have described a regular oscillation of the nucleus from side to side within the body of an infusorian.

6. Thanks to the investigations of Flemming, Strasburger, Klein, and others, we now know that the so-called granules of the protoplasm of cells belonging to all kinds of animal tissues are really the optical expressions of the thickened intersections of a delicate network of denser filaments—the *stroma*, between the meshes of which lies the more fluid

* Sur le Fluide Périvisceral des Oursins. Arch. d. Zool., Exp. VIII.

† Balfour, "Comp. Embryology," i., 1880.

‡ Ueb. amœboid. Kernbewegung, etc., Med. Jahrb. Wien, 1878, p. 393.

§ Journ. Roy. Micro. Sci., 1880, p. 407.

‖ (*a*) Observations on the Histol. and Physiol. of Convoluta (Proc. Roy. Soc., Lond., 1879); (*b*) Sur une nouvelle sous-classe d'Infusoires (Comptes Rendus, 19th Dec. 1881).

protoplasm. There is little doubt that a similar structure exists in the vegetable cell, although there the frequently enormous development of sap vacuoles presses the protoplasm into threads, as in *Spirogyra,* which cannot be fairly compared to a stroma. There is considerable evidence for believing that in muscle the fibrils represent the stroma; and Professor Haycraft * suggests that the pseudopodia amœboid cells are mere outflows of semi-fluid protoplasm, squeezed from between the meshes of the stroma by its contraction, the subsequent retraction of the pseudopodia being accounted for by the relaxation of the stroma, the viscosity of the interstromal matter, and surface tension. While no one who has observed the wonderful activity and the varied forms of pseudopodia emitted by many Protozoan forms (some amœbæ having two distinct forms of pseudopodium,† and some protruding cup-shaped processes ‡), or by the corpuscles of many invertebrates, particularly when uniting into a common amœboid mass,§ will accept the above as a satisfactory explanation; it is, of course, by no means impossible that we have here one of the factors of the process; nor indeed does Dr Haycraft demand much more.

7. The transformation of ciliated or flagellate cells into the amœboid state has been long known among such organisms as *Protomyxa,* Monads, etc.; and Huxley ‖ has insisted on the importance of the alternation between these forms, which he terms mastigopod and myxopod, in the morphology of the Protozoa.

(May not the *Mastigamœba* of Schultze and the similar organisms figured by Butschli and Savile Kent ¶—which are possessed of both pseudopodia and flagella—be simply forms of mastigopod, sketched during their assumption of the myxopod state ?)

* Proc. Roy. Soc. Edin., 20th Dec. 1880.

† Korotneff, Arch. d. Zool., Exp., 1878.

‡ (*Plakopus*).

§ Geddes, "Sur le Fluide Périvisceral des Oursins" (Arch. d. Zool., Exp. VIII.); and "On the so-called Coagulation of Invertebrate Corpusculate Fluids" (Proc. Roy. Soc. Lond., 1880).

‖ Huxley, "Anatomy of Invertebrated Animals," 1877.

¶ Manual of the Infusoria, London, 1881.

I am very strongly of the opinion that the same metamorphosis or degeneration from the ciliated to the amœboid state is of great importance in the histology of invertebrates. Not only does it frequently take place among ciliated embryos, but the amœboid corpuscles of many invertebrates (*e.g.* Echinus) develop in the same way from the ciliated epithelium of the perivisceral cavity.* So, too, I have elsewhere † described the remarkable transformation which occasionally takes place (doubtless as a pathological change) in the ciliated ectoderm of a planarian; and it is here possible to watch the actual transformation of cilia into pseudopodia, and even to see the two slowly contracting together. May not the assumption of this change with diminishing vitality throw light upon diseases of the ciliated epithelium of the trachea?

Chun has recently shown that, as had often been surmised, the vibratile bands of Ctenophores are simply united cilia, for when macerated they separate.

8. While the principal forms of contractile tissue are, of course, the muscular, the ciliated, and the amœboid, it is by no means correct to suppose that no other forms are known. The remarkable contractile collar of *Torquatella*,‡ the heart of Appendicularia,§ the extraordinary infusorian *Pulsatella*,‖ which moves by the rapid rhythmical contraction of *internal* fibrillæ around the large vacuole, are instances of new and strange modes of contractility; while the spermatozoa of Urodeles, which are provided with an undulating membrane along one side, or those of certain planarians,¶ where a regular series of waves runs continuously from one end of the spermatozoon to the other, increasing in velocity, though not in amplitude, towards the end which bears the flagellum, are, if possible, even more valuable as illustrations

* *Op. cit.*, Arch. d. Zool., Exp., 1880.

† *Op. cit.*, Proc. Roy. Soc. Lond., 1879.

‡ Lankester, *Torquatella typica* (Quart. Jour. Micro. Sci., vol. xiv., 1874).

§ Lankester, On the Heart of Appendicularia (Quart. Jour. Micro. Sci., vol. xiv., 1874).

‖ Sur une nouvelle sous-classe d'Infusoires (Comptes Rendus, 19th Dec. 1881).

¶ Geddes, On the Histology of *Convoluta* (Proc. Roy. Soc. Lond., 1879).

of the great variety of ways in which contraction may take place.

9. The circulation of protoplasm, which has so long been known and studied in such plants as *Chara*, *Nitella*, *Vallisneria*, etc., and which is believed to be of very wide distribution in vegetable cells, though little searched for in the animal kingdom, has been observed * in the cartilage cells of Geryonia. Unfortunately, no observations have been made upon the still more remarkable phenomenon of "aggregation of the protoplasm," discovered by Darwin † in the cells of the glands of *Drosera*, and observed by him also in the sensitive hairs of *Dionæa* and in the roots of various plants, save a single confirmatory paper by Francis Darwin; ‡ and it still remains to be investigated whether this remarkable process takes place in animal cells, whether it is related to circulation, and whether both are modifications of that irregular streaming which may be observed within the body of an amœba. Perhaps these phenomena may have something in common with those movements of the nucleus in animal cells above referred to; in any case a thorough comparative study of all these modes of protoplasmic motion is highly desirable.

10. In this relation, too, the contractile vacuoles of many zoospores, infusorians, etc., are worthy of attention. It has long ago been pointed out how the irregular disposed and non-contractile vacuoles of the lowest amœboid organisms become differentiated on one side into the large sap cavities of vegetable cells, and on the other into the regularly contractile vacuoles of many Protozoa. The most remarkable specialisation, however, is certainly that which I have recently described in *Pulsatella* § (see section 8, *supra*).

11. The coalescence of many amœboid cells into a continuous mass or *plasmodium* was discovered by De Bary to be a regular stage in the life-history of the Myxomycete fungi.

* Gegenbaur, Comparative Anatomy, p. 26.

† Insectivorous Plants, London, 1877.

‡ Aggregation in the Tentacles of Drosera (Quart. Jour. Micro. Sci., xvi., 1876).

§ *Op. cit.*

Hæckel has figured one of the Monera—his *Protomyxa aurantiaca*, which forms similar cell fusions. One or two similar Rhizopods have also been observed, and my own observations have shown that this tendency to union, apparently unimportant and rare, is really one of the best marked tendencies of the amœboid cell. For the corpuscles of invertebrates taken from various groups—urchins, starfishes, bivalves, gasteropods, worms, or crustaceans, all form plasmodia. The phenomenon can be best observed in the sea urchin, by suspending a drop of the perivisceral fluid from the under surface of a cover-glass placed upon a glass ring, of which the under side should be oiled to prevent evaporation. A little carmine or ultramarine may with advantage be added. Union takes place only between the finely granular corpuscles, which soon form an immense amœboid mass, which differentiates into granular endosarc and hyaline ectosarc, the latter of which sends out pseudopodia of extraordinary length and activity, which readily absorb any free corpuscles of the finely granular sort,—the coarsely granular corpuscles, like the foreign pigment granules, being simply taken into the interior of the mass.*

12. In my former papers on this subject I have compared these plasmodia to such Rhizopods as *Microgromia socialis* (Hertw.),† *Raphidiophrys*, etc., in which several constituent units are united by bridges of protoplasm. The well-known structure of Volvox, the beautiful *Moneron*, *Monobia confluens*, recently figured by Schneider,‡ and the remarkable recent announcement of Frommann § that the meristem cells of *Dracæna*, *Rhododendron*, etc., are in direct protoplasmic continuity by means of delicate filaments passing through foramina in the cellulose wall, however, when viewed together with the case of such Rhizopods, fur-

* Obs. s. l. Fluide Périviscéral des Oursins, Arch. d. Zool., Exp. VIII.; On the Coalescence of Amœboid Cells, etc. (Proc. Roy. Soc. Lond., No. 202, 1880).

† R. Hertwig, Ueb. *Microgromia socialis*, etc., Arch. f. Mikr. Anat. Bd. and Taf. 1, 1874.

‡ Arch. d. Zool., Exp., 1880.

§ Beobacht. üb. Structur, etc. d. Pflanzenzelle. Jena, 1880.

nish us with a type of the morphological arrangement and the physiological relations of vegetable cells alike distinct from this and from the ordinary one. The very deep pits in such thickened cell walls have often led vegetable histologists erroneously to imagine their protoplasm continuous; but the cases above mentioned, however, appear to me to furnish a considerable amount of new evidence in favour of that view; which, however, while very attractive, especially as serving plausibly to explain many remarkable physiological phenomena—such, for instance, as the propagation of an impulse through the leaf of Drosera—will require much farther research for its verification.

13. The question so long debated during the early days of the cell theory as to the nature and respective homologies of such structures as the cellulose wall and primordial utricle of the vegetable cell, the cysts of Amœbæ or Gregarines, the skeletons of Diatoms and Thalamophora, etc., the gelatinous investment of many Radiolarians, the matrix of cartilage, sarcolemma, neurilemma, intercellular substance, etc., still affords room for many detailed inquiries. We remain as yet completely ignorant of the laws of formation of such "organic crystallisations" as the skeletons of Radiolarians and Diatoms, though such siliceous deposits may yet furnish a transition from the chemistry of the carbon compounds to that of the analogous silicon compounds; or, still better, a glimpse into the play of forces within the protoplasm which produces them.

Nageli's theory of the growth of starch grains and cell walls by intussusception has recently been vigorously attacked by Schimper,* and I have pointed out that the cell wall in *Chlamydomyxa labyrinthuloides* is "distinctly formed by the deposition of successive laminæ, not by intussusception and subsequent differentiation, an important fact in view of the wide prevalence of the latter and somewhat overstrained theory"† (see fig. 4). The laminated structure of the cel-

* Bot. Zeit. 1880-81.

† Observ. on the Resting-Stage of Chlamydomyxa (Quart. Jour. Micro. Sci., Jan. 1882). See Strasburger's recently published work, "Ueb. d. Bau u. Wachsthum d. Zellhäute," Jena, 1882, in which a vast mass of similar evidence is adduced.

lulose coat in many algæ, *e.g.*, *Enteromorpha* (fig. 2), is also very evident.

14. Passing to the consideration of the modes of cell division, I shall not at present venture upon any bibliographical account, but content myself for the present by briefly referring to such contributions as I have already published.* The first relates to the process of cell multiplication by means of interlaminar gemmation (fig. 2). The second describes the origin of the brown corpuscles of *Echinus* by a process (highly suggestive of comparative researches) which appears to be a variety of that of free cell formation, from certain of the pigment granules which occur in masses in certain portions of the blood vessels and water-vascular system (fig. 1). Finally, I have figured specimens of Chlamydomyxa, which at least closely simulate, if they do not, as is much more probable, absolutely represent all the main modes of cell multiplication —transverse division, gemmation, free cell formation, and rejuvenescence—with which we are acquainted, and which at any rate assist us in imagining how these processes have arisen (see fig. 3).

Explanation of Plate.

Fig. 1. Endogenous (?) development of brown amœboid corpuscles of sea urchin : † *a*, three of the yellow granule-masses from the ambulacral pouch, with one free brown corpuscle (at left hand upper corner); *b*, *c*, *d*, similar granule-masses from intestinal blood vessel, the two latter showing one or two of their constituent spherical bodies enlarged and darkened in colour; *e*, a granule-mass with dark coloured body, now of irregular form ; *f*, the same under pressure ; at *g*, completely expressed (born, in fact) as a brown amœboid corpuscle ; *h*, another brown corpuscle, more highly magnified, and showing dark coloured granules in colourless protoplasm ; *i*, the same corpuscle killed and decolorised ; *j*, a corpuscle crushed ; *k*, proliferation and escape of small spherical yellow bodies (nucleoli ?) from nuclei of epithelial cells of ambulacral pouches, by union or division of which the yellow granule-masses seen in figs. *a*, *b*, appear to originate.

Fig. 2. Cell-multiplication by *interlaminar gemmation* in *Enteromorpha* : ‡ *a*, a filament with laminated structure of cellulose brought out by weak

* *Op. cit.*

† S. l. fluide Périviscéral d. Oursins, Arch. d. Zool., Exp., vol. viii., pl. 38.

‡ On the Phenomena of Variegation, etc., in Enteromorpha (Trans. Roy. Soc. Edin., vol. xxix., pl. 12).

potash ; *b, c, d, e, f,* filaments showing small new cells destitute of chlorophyll, single, or forming colourless shoots ; *g, h,* filaments more highly magnified, showing origin of the colourless cells by gemmation of the protoplasm (from below the chlorophyllaceous layer) of the green cells, into the lenticular or angular spaces between the laminæ of cellulose. The same is seen two-thirds down *b.*

Fig. 3. Union of amœboid cells into a plasmodium :* *a,* amœboid cells of perivisceral fluid of a star-fish, freshly drawn ; *b,* the corpuscles sticking together in a group ; *c,* the same completely fused into a plasmodium ; *d,* a corner of the large and active plasmodium formed by finely granular amœboid corpuscles of the sea urchin. With the most trifling modifications, the same figures, more especially *a, b, c,* would serve to represent the formation of plasmodia ; (1) in the so-called coagulation of any invertebrate corpusculate fluid ; (2) in Hackel's *Protomyxa aurantiaca,* and other forms of Protozoa ; (3) in Myxomycete fungi.

Fig. 4. Diverse modes of multiplication in *Chlamydomyxa labyrinthuloides* (Archer) : † *a,* a spherical specimen ; *b, c,* mass divided two and four respectively, recalling the transverse division of *Protococcus ; d,* a specimen recalling the transverse division of an amœba ; *e,* a flat amœboid mass just beginning to throw out a cellulose coat, apparently after rejuvenescence ; *f,* a specimen in process of gemmation, recalling the process of cell-multiplication in *Torula ; g,* a specimen containing several smaller encysted masses—endogenous division. The formation of the cell-wall from successively deposited laminæ is particularly well marked in *e, g.*

XVI. *Notes of an Entomological Excursion to the New Forest, Hampshire, in July* 1880. By William Evans, Esq.

(Read 21st December 1881.)

Abstract.

In this paper the author gave an account of a three weeks' excursion to the New Forest undertaken by him in July 1880. A small hamlet called Bank was chosen for headquarters, and in its immediate neighbourhood, as well as in those parts of the forest stretching out to Lyndhurst on the one hand and Brockenhurst on the other, the bulk of the collecting was done.

Having indicated the position of the forest, and referred to its antiquity and historical associations, the author proceeded

* On the Coalescence of Amœboid Cells, etc. (Proc. Roy. Soc. Lond., vol. xxx., pl. 5).

† Observ. on the Resting Stage of *Chlamydomyxa,* etc. (Quart. Journ. Micro. Sci., vol. xxix., pl. 5).

to give a short description of the place and its scenery (photographs were exhibited). The New Forest, it was stated, is, according to guide-books, about 60 miles in circumference, and covers something like 70,000 acres of country, the greater portion of which still belongs to the Crown. Within its boundaries, however, there are now many gentlemen's seats and freehold estates, quite independent of the forest laws. The Crown lands—which are under the control of a lord warden—consist of woodland interspersed with open heaths. The woods, which in many places are very dense, are composed mainly of oak, beech, and fir, the younger plantations being fenced off into what are known as the 'enclosures.' The abundance of old trees of large dimensions is a characteristic feature of the forest; and one had but to reflect for a moment on the fate which, in a greater or less degree, has, in those utilitarian days, overtaken other old English forests, to perceive what an insect stronghold such a locality must be, and how it is that species, which doubtless once had a wide distribution in the country, are now found exclusively, or at least chiefly, within its precincts. Birds, too, are still abundant there, and find a welcome home within its shady solitudes, where the harsh cries of the jay and the green woodpecker often startle the pedestrian. On bushy heaths the turtle dove was frequently both heard and seen; and eggs of the greater spotted woodpecker, still unblown, were offered for sale by an old gipsy.

The author then gave a list of the more interesting insects taken, with remarks. (Specimens of eighty species were exhibited.) The diurnal Lepidoptera were not numerous as regards species at the time of his visit; but this was, in one point of view, fully compensated for by the great abundance of those which were present.

After noticing some of the commoner species of *Diurni*, such as *Satyrus Ægeria* (Speckled wood), etc., reference was made to the abundance of "Fritillaries" seen. *Argynnis selene* was nearly over, but a few—along with *A. aglaia*—still lingered in boggy heaths near woods. Many fine specimens of *A. adippe* were observed coursing up and

down open grassy paths; but the butterfly of the forest was undoubtedly *A. paphia* (Silver-washed F.), which literally swarmed everywhere. It frequented even the densest parts of the enclosures, where dozens might be seen at a time, resting on the ferns with expanded wings, their bright tawny colour making them conspicuous objects in the midst of the surrounding green. Their favourite plant, however, was the bramble, on a single bush of which over thirty perfect specimens were once counted busy sipping the nectar from the blossoms. On another occasion, while collecting in a small pasturage in which grew a most luxuriant crop of tall thistles, the author found *Paphia* in greater abundance than he had yet seen it. On every thistle-head there were two or three striving for possession. While speaking of this species, special attention was drawn to the melanic form known as var. *Valezina*. This southern form, it was understood, had rarely, if ever, been taken in the British Isles except in the New Forest; and, until recent years, only in very limited numbers even there. It was certainly in considerable plenty in July 1880. He himself saw a goodly number on the wing, and was shown over fifty fine specimens in the store-boxes of two Oxford students. Several other similar 'takes' were heard of. *Valezina* differs from the typical form only in colour, being, in good examples, of a uniform dark smoky green, through which the usual darker markings are distinctly visible. Towards the tip of the anterior wings there are two or three pale, whitish spots. The strange thing about this variety is, that it only occurs among the females—it being understood that not a single *Valezina* male has yet been seen. Another curious form of *A. paphia* was observed, namely a specimen in which the two right wings were most perfectly those of the male and the left ones those of the female. This form of Gynandromorphism is not so uncommon, however, as some others. There was another inhabitant of the New Forest, which, in some respects at least, was the proud superior even of *Paphia*. He referred to *Limenitis sibylla* (White Admiral). The charm of *Sibylla* lay in its power and grace of flight. Through a long summer day he had with unwearied interest

watched them pursuing their airy courses—one minute soaring around the summit of the tallest oak, the next descending to the lowly bramble or honeysuckle. Owing to its strong flight, and the conspicuous way in which the slightest scratch shows on the dark surface of the wings, it was no easy matter to secure a series of perfect specimens.

Referring to the Purple Emperor (*Apatura iris*), the author stated that, while searching for the larvæ of the Puss moth in a willow bed near the Queen's Bower Wood on the 17th July, he came upon the pupa of this rare insect suspended from the under side of a leaf of *Salix cinerea;* and on a subsequent day the noble insect itself was seen soaring high over the tops of the trees. Some days later he was shown a pair (male and female), newly put on the setting-board, which had been taken somewhere in the Brockenhurst direction while feasting on carrion. The male was rather ragged, but still full of the purple lustre so conspicuous in fresh specimens. The female was perfect, and of large size.

Among the other *Diurni* mentioned in the paper were *Gonepteryx rhamni, Leucophasia sinapis, Pieris cratægi, Thecla quercus, Lycæna Ægon,* and *Nemeobius lucina.*

Of the *Nocturni* seen, the most interesting, perhaps, were two species of *Lithosia*, or Footmen, viz., *L. quadra* and *L. helveola.* The shining black pupæ of the former were abundant in crevices in the rough bark of old oaks, secured by very slight silken webs; and the moths themselves were found common enough at rest on the tree-trunks from the 19th of the month onwards. The female with its orange-coloured wings adorned with four blue black spots, is a conspicuous insect, and presents quite a contrast to the male clad in pearly grey. *L. helveola,* which is a good insect, was taken in some abundance by beating the lower branches of beeches. The pretty *Euthemonia russula* (Buff Tiger) was tolerably plentiful in open heathy places, and in walking over such ground the male was often started. The female, which is — contrary to the general rule among Lepidoptera—smaller than the male, was, as usual, much less frequently seen. While speaking of the "Tigers," the following incident was narrated. From eggs of the common

garden tiger (*Chelonia caja*) between twenty and thirty caterpillars were obtained. They were all hatched on 25th July, apparently under exactly the same conditions, and at an early stage of their existence ten individuals showed a marked tendency to outgrow their neighbours: so much faster was their development, that, on 25th September, they had attained their full size, and with one consent began spinning up, whereas the other members of the family had scarcely completed one-fourth of their growth, at which stage they hibernated for the winter. These hibernating larvæ awoke from their sleep on 18th March, and were simultaneously full fed and spinning-up on 2d June. There was thus nearly eight months and a half between the dates of the two sections going into pupæ, in which stage the former all died just as the insects were about to emerge from their prison walls, while the latter all came forth beautiful moths about the middle of July. Under ordinary circumstances the larva of this insect was understood always to hibernate and to change to pupa in early summer; and the author had been unable to discover any cause for the partial departure from the rule in the above instance.

A number of good *Geometræ* were obtained, among which may be mentioned the following:—*Amphidasis prodomaria* (whose curious twig-like larvæ were obtained from oaks by beating the branches), the rare *Cleora glabraria*, and the local *Boarmia roboraria*. *C. glabraria* was obtained principally in the larval state, feeding on a species of shaggy grey lichen, to which it exactly corresponds in colour. *B. roboraria* had been out some time, but still a number of fine examples were captured in the early part of the month. During the day it rests on oak trunks, usually at a considerable height, with wings spread flat against the bark, looking exactly like a patch of grey lichen; and this, combined with its habit of darting off just as one gets within reach of it, renders it somewhat difficult to capture. Four specimens of the beautiful banded form of *Boarmia repandata* —so much prized by collectors—were also obtained. Among the other good *Geometræ* taken were *Eurymene dolobraria*, *Phorodesma bajularia*, *Geometra papilionaria*, *Macaria alter-*

nata (single specimen), *Selidosema plumaria* (males abundant in heath near Lyndhurst, but only one female got), and *Cidaria psittacata* in larval state. For the information of botanists it was stated that in boggy parts of the heath just referred to the local little *Lycopodium inundatum* was very abundant. *Gladiolus illyricus*, however, appeared to be fast disappearing from the forest—a single specimen in Fletcher's Enclosure being all that was observed.

Cuspidatæ.—This is a group containing comparatively few species, all of which, however, are particularly interesting. With few exceptions they appear on the wing in early summer or even in spring, while those that are double-brooded—the Hooktips—do not appear the second time till August or September. It was, therefore, almost entirely in the larval state that examples of this group were met with. These larvæ present marked peculiarities of form; and several have a most grotesque appearance, noticeably the "Puss" and the "Lobster." The four Hooktips—*Platypteryx lacertula, P. falcula, P. hamula,* and *P. unguicula*—appear to be pretty common in the forest. July, however, is not the season for them—a single specimen of *P. falcula*, and the larva of *P. lacertula*, being all that were observed. The author was told on his arrival at Lyndhurst that a late specimen of *Stauropus Fagi* (the Lobster)—which usually appears on the wing in June—had been taken a few days before; and on the 18th July he had the satisfaction of taking another—a male—with his own hands. It was at rest on a beech and had to be climbed for, but otherwise was easily captured. He had not the good fortune, however, to meet with the remarkable caterpillar of this rare moth, though several in a very young state were obtained by other collectors. Of the fine genus *Notodonta* several were obtained, the larva and the imago of *N. camelina* occurring simultaneously. Nothing could more completely resemble a withered leaf than this moth when at rest. Young larvæ of *N. dromedarius* and of *N. ziczac* were secured in the very end of the month, and those of *N. dictæoides* were received from the forest in September. The finest caterpillar obtained was that of *N. trepida*. This insect, though

occurring in several English counties, is always esteemed a rarity; and the capture of ten full-grown larvæ in the course of a few days' beating was considered more than ordinary luck. This caterpillar measures about three inches in length, and the prevailing colour is apple green becoming slightly glaucous on the dorsal surface. There are two approximate pale yellow stripes along the back, and the sides are ornamented with a series of conspicuous oblique stripes of a pink colour. A peculiarity of these lateral stripes is that they slope from the anterior part of the segments backwards, which is just the reverse of what occurs on the Hawk-moth larvæ. Half a dozen larvæ of *N. chaonia*, another widely distributed but rare insect, were also captured by beating oaks. The general colour of this caterpillar is pale blue-green, sometimes approaching to glaucous. There are two narrow yellow stripes on the dorsal surface, and along each side there is also a yellow stripe which dilates at each spiracle. Both the *N. trepida* and *N. chaonia* larvæ yielded fine moths in the spring. Larvæ of *N. dodonæa* were also obtained.

Noctuæ.—This large group appeared to be very sparingly represented during the month; at all events treacling—by which large numbers are usually captured—was singularly unproductive. This, however, might be in great measure owing to the abundance of honeysuckle, bramble, and other blossom in the woods at that season. During the end of June and the first week in July, numbers of *Diphthera Orion* and *Leucania turca* had been taken, but by the time the writer commenced treacling they were nearly over, and a few only were obtained. The most frequent visitor to the sweet mixture was *Thyatira batis,* with an occasional *T. derasa, Gonoptera libatrix,* etc. *Amphipyra pyramidea* put in an abundant appearance the last night treacling was tried. On the 28th July the writer had the satisfaction of taking the extraordinary larvæ of *Acronycta Alni*—one of the rarest of our indigenous *Noctuæ.* A good many appeared to have been taken about the same time, and a local collector was subsequently selling the pupæ at 10s. each. This caterpillar is very striking in appearance, and quite unlike any other

of the genus; indeed, the great contrast which the larvæ of *Acronyctæ* bear to each other is a most remarkable fact. In *A. Alni* the body is of an intense purple-black with a series of tranverse oblong blotches of pale lemon yellow—one on each segment; and along either side there is a row of hair-like appendages, each flattened at the tip into a sort of club. A few of the larvæ of *A. leporina*—also a good insect—were obtained by beating birches. Here the body—which is of a delicate pea-green—is densely covered with long silky hairs of a beautiful canary yellow. Unfortunately, the author had to leave the forest before the famous "Crimsons"—*Catocala promissa* and *C. sponsa*—made their appearance. He had scarcely left when *C. promissa* came forth, and by-and-by *C. sponsa* abounded. A boxful was received from the son of one of the foresters.

Of other tribes the only species of any consequence obtained was *Halias quercana*—an insect as beautiful as it is rare. Two specimens only were observed.

XVII. *On Specimens of "Tailless" Trout from Loch Enoch, in Kirkcudbrightshire.* By Dr R. H. Traquair, F.R.S.

(Read 18th January 1882.)

At the meeting of the British Association at Edinburgh in 1871, Mr C. W. Peach exhibited specimens of a peculiar variety of the common trout from Loch na Maorachan in Islay, characterised by an apparently abortive condition of the caudal fin, which had gained for it the popular name of "Tailless Trout." Professor Turner and Mr Peach having been kind enough to supply me with a few specimens of this abnormal form, I published a description of its structural peculiarities in the sixth volume of the "Journal of Anatomy and Physiology." By referring to this paper it will be seen that the most salient peculiarity of the so-called tailless trout of Islay is the condition of the rays of the caudal fin, "which are abnormally shortened, are coarse at their extremities, and deficient as to amount of dichotomisation and number of transverse joints; besides which they also show a tendency

to coalesce at their terminations. By the convergence downwards of the upper long rays, and upwards of the lower ones, the fin assumes a rounded form, instead of presenting the usual broad fan-shaped aspect." I also showed that a similar condition might also affect other fins, more especially the anal and pectoral, though to a less extent than the caudal; the dorsal, however, being normal in every specimen I had examined.

On the occasion of these fish being first exhibited to the British Association, Dr Grierson of Thornhill mentioned that he had heard of similar "docked" trout having been taken near Wanlockhead in Dumfriesshire, but I have not learned that that gentleman has as yet succeeded in obtaining actual specimens from that locality. The Museum of Science and Art is, however, indebted to Mr Harvie-Brown for two specimens of "tailless" trout from Loch Enoch in Kirkcudbrightshire, which he himself recently obtained from Mr Adam Skirving of Croys. These specimens form the subject of the present communication.

They are both of small size, the larger being 6, the smaller $5\frac{5}{8}$, inches in length. They are dark in colour and very closely spotted, and, apart from the peculiarity of the caudal fin, their external appearance is remarkable, owing to the proportionally large size of the head, the length of which, from the tip of the snout to the posterior margin of the operculum, is contained little over $3\frac{1}{2}$ times in the total. The form of the caudal fin and the condition of its rays is identical with that in the specimens from Islay, and consequently requires no further description. In both specimens there is also some affection of the rays of the pectoral and anal fins, though this is most evident in the larger individual. The dorsal fin is perfectly normal, as are also the ventrals, although the latter appear a little small in proportion to the size of the fish.

The disproportionate size of the head gives those fish a somewhat uncouth appearance, which contrasts strangely with the graceful figue of the normal *Salmo fario*, but there is, however, no evidence of any specific difference.

The fact of all the trout in a small lake in Islay being affected with this singular condition of the caudal and other fin rays, is a strange enough circumstance in itself, but the

reappearance of the identical malformation in a locality so distant as Kirkcudbrightshire is still more remarkable. And from various reports which I have heard of the occurrence of similar trout in other localities in the south of Scotland, there seems little reason to doubt but that the "tailless" trout will prove to be a more common phenomenon than has been hitherto supposed. But as regards the cause and origin of this malformation our ignorance is still as complete as before, and the whole subject is one which is worthy of a thorough investigation.

XVIII. *On the Occurrence of Pallas's Grey Shrike in Scotland.* By HENRY SEEBOHM, Esq., F.Z.S., etc.

In the Museum of Science and Art in Edinburgh, there is a specimen of Pallas's Grey Shrike, which was shot near Kirriemuir in Forfarshire, in the winter of 1869.

This species appears to be a comparatively frequent visitor to our islands, though it has hitherto been overlooked, probably in consequence of its similarity to its western ally. I recently exhibited, at a meeting of the Zoological Society in London, a fine specimen of the eastern form, which had been obtained near Swansea; and Dr Gadow, who is employed at present upon the eighth volume of the Catalogue of Birds in the British Museum, in which the shrike will be included, informs me that there are two examples in the national collection of British-killed Pallas's Grey Shrikes.

Dresser, in his "Birds of Europe," does not include this species, though he describes the young from Siberia as an extraordinary Grey Shrike to which he is unable to give a name. He seems to have been entirely unacquainted with this interesting species, or to have confounded it with our bird. The two species are very distinct, and have distinct geographical ranges. In the Great Grey Shrike (*Lanius excubitor*), the outer webs of the primaries are white at the base, and thus, when the wing is closed, a white bar is formed across the part formed by the primaries. In Pallas's Grey Shrike (*Lanius major*), exactly the same occurs, so that so far as the primaries are concerned, there is no difference in

the two species. When we come to look at the secondaries, we shall, however, find that in *L. excubitor*, the bars of their outside webs are also white, so that two white patches or bars are formed on the wings, whilst in *L. major*, there is no white at the base of the outside webs of the secondaries, so that only one white patch or bar is formed on the wing. Some ornithologists have suggested that *L. major* is the young of *L. excubitor*, but nestlings of the latter species, in which the wings are not even fully grown, show the two white patches almost as distinct as adults. Further east still, a third species occurs, *L. leucopterus*, in which the whole of the inside web, and all except a narrow streak near the centre of the feather adjoining the shaft of the outside web, is white. The white at the base of the primaries also extends to twice the distance that it does in the other two species. *L. major* breeds in Central Scandinavia, North Russia, and across the whole of Siberia up to about lat. 60°. *L. excubitor* breeds in Europe south of lat. 50°, as far east as Moscow, and *L. leucopterus* in Turkestan and South Central Siberia, as far east as Lake Baikal.

But now comes the curious part of the history of these birds. In the valley of the Yenisei, both *L. major* and *L. leucopterus* are found, so far as we know perfectly distinct species, which are too wide apart ever to interbreed, though their geographical areas there overlap, and give them every opportunity of doing so. It would appear, however, that the intermediate form, *L. excubitor*, is near enough to each of the two extremes to interbreed with either of them, for in Scandinavia and North West Russia, where the geographical areas of *L. excubitor* and *L. major* impinge, every intermediate form between them occurs; and in South Eastern Russia and Western Turkestan, the white on the wings of the Grey Shrikes gradually increases as you go eastward, so that in the intermediate localities between the eastern limit of true *L. excubitor* and the eastern limit of true *L. leucopterus*, a complete series of intermediate forms between the two are obtainable.

PROCEEDINGS

OF THE

ROYAL PHYSICAL SOCIETY.

SESSION CXII.

Wednesday, 15th November 1882.—RAMSAY H. TRAQUAIR, Esq., M.D., President, in the Chair.

The CHAIRMAN delivered the following opening address:

GENTLEMEN,—In opening the one hundred and twelfth session of the Royal Physical Society of Edinburgh, I must first express the regret which, I am sure, is shared in by every one present, that Professor Archibald Geikie is unable to occupy the chair this evening, and to deliver, in accordance with the time-honoured custom of the Society, his address to us as retiring President. But I am also sure that we will all, at the same time, cordially excuse his absence on this occasion.

Professor Geikie's removal to London, where he is now taking up the duties of the distinguished post of Director-General of the Geological Survey of the United Kingdom, effectually prevents his being present to occupy the chair on this occasion. I am, however, happy to say that we have the bright prospect before us that, before the conclusion of the present session, Professor Geikie will take an opportunity of being present with us, and of then delivering the address which, in the normal course of events, would have been given this evening.

While we must all rejoice in the recognition of his merits,

which has raised him to the highest post of honour in the British Geological world, it is also impossible for us to suppress some feeling of selfish regret at the loss we sustain in Professor Geikie's removal to London. Of this, however, I am convinced, that he will not forget the Royal Physical Society, nor cease to sympathise with its aims and objects.

What are these aims and objects? A strange question some of you may say—do we not know our own minds? No doubt all of us know and maintain that the Royal Physical Society exists for the purpose of encouraging the study of Physical Science, as well as of promoting the ready interchange of ideas among its members as to the subjects which interest them: our publication of proceedings, which we exchange with those of other societies throughout Europe, also shows that we wish the world, outside our boundaries, to know what we are about, if it cares. We may not, however, all entertain quite the same idea as to the special way in which science may be encouraged and benefited through the means of our Society; in fact, different opinions may be held regarding the appropriate part which we may pursue, and the end at which we may aim. I hope you will not consider me as egotistic if, on the present occasion, I venture to give you one or two of my own ideas on the subject.

First, As to the *scope* of our studies. I find the idea very prevalent outside our circle, as well as indeed within it, that the Royal Physical Society of Edinburgh is pre-eminently a Zoological Society. But, by the original constitution and charter, all Physical Science is embraced in the scope of its work, and, in the old days of the Society, the mass of the papers read were purely medical in their character.

However, since our Society commenced the publication of *Proceedings*, it is true that Natural History has formed the most prominent part of its work, and that a great deal of the best work which has appeared in these *Proceedings* is Zoological in its nature. And, from the nature of things, I rather think that Natural History will continue to form the staple pabulum of our monthly meetings. The medical men have now their own societies for the discussion of topics specially connected with the profession, and which discus-

sions would indeed be a little out of place in an audience largely composed of laymen.

As a rule, too, I also fear that the workers in mathematics and physics will prefer to lay their communications before societies which have previously laid themselves more out for that manner of work. We should, however, be heartily glad to receive papers in those subjects as well as in Chemistry, and here we may congratulate ourselves on the fact that, amongst those who have taken an interest in the society of late years, and have contributed considerably to its prosperity, are several gentlemen who follow chemistry as a profession.

But, by Natural History, I mean Natural History in its widest sense, not Geology only, but Zoology, Botany, and Geology. However, as regards Botany, seeing that there is also an excellent Botanical Society in Edinburgh, there is no necessity for us endeavouring to push that part of the subject. From the connection, however, of all palæontological work with Geology, papers on Fossil Botany will, I have no doubt, be highly appreciated by our members, and I am glad to say that our *Proceedings* have latterly been enriched by more than one valuable contribution on the structure of carboniferous plants.

In Zoology and Geology the field is open. And under Zoology I would include everything relating, not merely to the external configuration and habits of animals, but to their internal structure, physiology, and morphology, and though of deep interest and importance to the geologist, I also maintain that the study of fossil animals is a part of Zoology. In the field of Natural History, as well as of science in general, there is plenty of work for every one; he who can devote enthusiasm, industry, patience, and time to work, will speedily find out for himself a subject for original investigation.

Second, As to the nature of the communications appropriate for this Society. According to my apprehension the great object of the Royal Physical Society is to encourage its members to [illegible] study of science, in the field or in the la[illegible] n facts of interest

or value are elicited, to bring them before the Society for discussion and publication. It is true that, as regards what may be called "big papers," that is, papers containing the result of much labour, and embodying much new and valuable fact, with or without important generalisations as the case may be, our Society, with its limited pecuniary resources, cannot expect to compete with the Royal Society of Edinburgh, or any of the great London societies. We cannot ask an author to present valuable work to us which we would not be in a position to publish as it ought to be published. It must be kept in mind that in none of these great societies to which I refer is the annual subscription under £2, 2s., and their membership under 400. What can we do with our 220 members, and 12s. 6d. subscription, to compete with these?

Nevertheless I think we are right in requiring that papers handed in, to be read at our meetings, shall be the result of the personal observation and work of the writer, and not mere compilations. Exhibitions of specimens, however, come under quite a different category; here the interest centres in the opportunity afforded to members of seeing or closely examining objects of special interest and rare occurrence, and the exhibitor is, in this case, not required to accompany such exhibition by a paper containing original matter.

So far as our *Proceedings* are concerned, I think also that, both for the purpose of economising our slender means, as well as for the higher object of keeping up the character of these volumes, it is inadvisable to publish papers which do not contain observations and facts worth recording, from a purely scientific point of view. Our yearly volume ought not, in my opinion, ever to be looked upon as a sort of popular magazine; as such it never could emulate the *Popular Science Review*, or even *Science Gossip*. But if it is true to its own place and function it will, year by year, add one to a series, which will, as time goes on, become indispensable to every public library frequented by scientific workers for purposes of work. I have said that we cannot expect men to give in their big papers, but there are, or ought to be, always plenty of little ones going, and these, especially such

as deal with matters of local interest, are precisely the papers for our Society.

I do not make these remarks *ex cathedrâ* in any spirit of assumed superior wisdom to the rest of my fellow members, but simply as one friend talks to another over a matter in which both are interested. We are all interested in the honour and welfare of our Society, and, as regards the past session, I think that, on the whole, we have fair reason for congratulating ourselves.

The roll of members at present musters:—

Ordinary Fellows,	220
Non-resident Fellows,	51
Corresponding Fellows,	15
Honorary Fellows,	24
Total,	310

XIX. *On a New Nematoid Worm.* By Frank E. Beddard, M.A. Oxon., F.R.S.E., Naturalist to the "Challenger" Expedition Commission. [Plate IV.]

(Read 20th December 1882.)

The Nematoid which forms the subject of this communication was found in tolerable abundance in the perivisceral cavity of a large earthworm from Ceylon, which was described by me in a paper read before the Royal Society of Edinburgh in April 1882. Two specimens only, which fortunately turned out to be a male and a female, were preserved; they were stained in picrocarmine, and mounted on a slide in glycerine.

Both specimens are as nearly as possible of the same size —about $\frac{1}{8}$ inch in length; the body terminates in a long tail, which, in the female at least, is about a quarter of the entire length of the animal. Just at the commencement of the tail, and posterior to the anus, there are in the female two large suckers (Fig. 1) of equal size, and situated on opposite sides of the body; they are not, however, arranged symmetrically, one being considerably anterior to the other. These do n[illegible]t in the male, but I cannot

be quite certain, since the end of the body was tightly twisted into a spiral, which I found it impossible to unroll. The body is covered with a chitinous cuticle, which, as in most other Nematoids, is divisible into several layers. The cuticle is far more strongly developed in the male, and consists of (1.) an outer layer, which, in optical longitudinal section, is homogeneous, but, viewed from above, shows a wavy longitudinal striation, and readily splits into fibrils, the margins of which correspond to the striæ; on the under surface of the body, in the posterior region, where the cuticle is greatly thickened, this outer layer is made up of two distinct lamellæ. (2.) The inner layer of the cuticle is the most important; it is homogeneous in optical longitudinal section, and the upper and lower margins are crenate in outline. Figs. 2 and 3 represent the two layers of the cuticle in the posterior half of the body in the male; they are drawn to the same scale to show the relative proportions of the thickness of the cuticle on the upper and lower surfaces. Fig. 3 is taken from the lower surface, and it will be noticed that the whole cuticle, and especially the inner layer, is here greatly increased in thickness, which is correlated with the presence of a series of muscles attached to the cuticle, and running diagonally across the body. They are found in the males of many Nematoids,* and serve to connect the body wall with the ductus ejaculatorius, assisting no doubt in the passage of the semen down the latter. In the anterior half of the body the cuticle diminishes considerably in thickness.

In the female the cuticle is exactly similar in structure, but differs in not being so strongly developed. At the anterior extremity (Fig. 4) the inner layer disappears in both sexes, and the outer layer alone is present.

In most *Nematoidea* there are several papillæ arranged round the mouth, which vary in number and position in different genera; they are formed by a prolongation of the cuticle, and contain in many cases a delicate granular core, which is probably of a nervous nature, the papillæ performing the

* Compare, *e.g.* figure of Mononchus given by Bütschli (Zeit. für Wiss. Zool., vol. xxvi.), where the structure of chitinous cuticle is very similar to that described here.

function of tactile organs. In the species that I am describing here there is only one mouth papilla, which is curved outwards and downwards, its general direction being nearly at right angles to the long axis of the body (Fig. 4). There is, so far as I am aware, no genus of Nematoids in which the mouth papillæ are reduced to a single one, though there are many genera in which they seem to have disappeared altogether; the only thing that suggests itself as at all comparable is the single boring papilla ("bohrzahn") found in the young of *Ascaris* and *Cucullanus*.* If this comparison be just, we have here an interesting survival in the sexually mature worm of a larval structure.

The alimentary canal consists of three divisions (1.) œsophagus; (2.) intestine; (3.) rectum.

The œsophagus occupies about one-tenth of the whole length of the alimentary canal, and appears to be covered externally, and lined internally by a thin chitinous layer. The opening of the mouth is not exactly terminal, it is very slightly ventral in position. A chitinous ring is continuous, save for a small space, round the whole circumference of the aperture.

The œsophagus is cellular in structure, not muscular, the constituent cells being easily distinguishable, especially in the hinder portion. The free-living forms very frequently possess a cellular œsophagus; according to Dr Bastian,† this is the case in about one-half of the known forms, while among the parasitic genera a muscular structure is the rule, but is not found in *Trichosoma, Trichocephalus*, and *Trichina*. An *Oxyuris* also is figured by M. Osman Galeb,‡ with a distinctly cellular œsophagus; but the number of parasitic forms which are thus characterised is not large, and Bütschli, who has of late years published a great many memoirs on the *Nematoidea,* more especially the free-swimming forms, remarks:§—"One thing appears frequently in the histological structure of the œsophagus of the free-living forms which is

* Leuckart, Die menschlichen Parasiten, Vol. II.; Linstow, Arch. für Naturg., 1878.

† Phil. Trans., 1866. ‡ Arch. de Zool. Exp. 1878.

§ Abh. Senk. Naturf. Gesell., Frankf., bd. ix., p. 9

generally not clear in the parasites—the indication of a cellular composition."

Correlated with the absence of muscular tissue in the œsophagus is an absence of cuticular teeth.

The second division of the alimentary canal—the intestine—is marked off from the œsophagus by a sharp constriction, and by a difference of tissue, which is shown by the different way in which the staining reagent has acted upon it. The cells are nucleated and of an oblong shape, and contain numerous granules; they are arranged in a single layer round the lumen of the tube. The diameter of the intestine is hardly more than half that of the œsophagus.

The terminal part of the alimentary canal is only to be distinguished from the intestine by its greater calibre, and strongly marked cuticular lining. It extends in the female from a point considerably anterior to the generative opening, the precise position of which it was impossible to determine, owing to its being covered by the coils of the generative tube. In the posterior third of the body, the alimentary canal becomes wider still, and, at the extreme end, undergoes a further dilatation, and opens to the exterior by the ventral anus which is situated some way in front of the two suckers (Fig. 1).

Scattered throughout the body, and lying apparently in the perivisceral cavity, are a quantity of round bodies, which look like oil globules. I could only find them in the female, where they exist in great numbers, especially in the tail and the hinder part of the body (Figs. 1, 5). They may be the contents of some of the eggs which have got broken.

The generative organs conform to the type that is generally found in the parasitic Nematoids. The ovarian tube commences between the suckers, and runs forward nearly as far as the hinder end of the œsophagus; it is then bent upon itself, and coiled several times, and opens by a wider terminal portion, which contains fully formed eggs in various stages of development, and corresponds to a vagina. The generative aperture is situated about the middle of the body. In the male the testicular tube commences about the end of the anterior third of the body, and after running forward for a

short distance, is bent upon itself, and continues its course as a straight tube to the end of the body, where it opens on to the exterior; the posterior half of the tube is not concerned in the production of the spermatozoa, and serves as a vas deferens. At the opening of the vas deferens three chitinous spicules are found, of which one is rather smaller, and corresponds to what is called in other Nematoids the "accessory piece."

Having described the anatomical characters of this Nematoid, its systematic position remains to be decided. The presence of the two caudal suckers and the single mouth papilla are, perhaps, the most salient characters, and of these the caudal suckers distinguish the genus *Dicelis.** This genus was founded by Dujardin, in 1845, for the reception of a parasitic worm occurring in the testes (vesiculæ seminales) of the common earthworm. There is only one species (*D. filaria*) which is characterised by two suckers on either side of the tail behind the anus, arranged symmetrically; the tail is very short; the mouth unprovided with papillæ; the œsophagus muscular; the integument transversely striate; the male provided with two spicules, and an accessory piece. It is clear, therefore, that my Nematoid forms a well-marked new species, and I propose to call it *Dicelis Pleurochætæ*, the specific name recording the genus of which it is a parasite.

D. Pleurochætæ, although a parasitic form, shows a good many resemblances to the free-living Nematoids, which group, according to Dr Bastian,† form not only a physiological but also a morphological assemblage, agreeing among themselves, and differing from the parasitic genera in a number of anatomical characters. Those cases where Nematoids are found seemingly as parasites, though with structural affinities to the free-living forms, may sometimes be explained by the hypothesis that they are accidentally present in the body of their host. *Dorylaimus stagnalis*, found by Dujardin ‡ in the intestine of the carp, had in all probability been swallowed along with the food of the animal; and *Dicelis filaria* may easily, Dr Bastian suggests, have found its way when young

* Dujardin, Hist. Nat. des Helm. (Paris, 1845), p. 108, and Pl. iii., Fig. H.

† Trans. Linn. Soc., 1865.

‡ Dujardin, *loc. cit.*, p. 231.

through the apertures of the segmental organs of the earthworm.

M. Perrier * has described a Nematoid, *Dionyx Lacazii*, which he found encysted in the transverse muscles of *Pontodrilus*, the male agreeing with the free-living forms by the possession of two intromittent spicules and an accessory piece. This affinity is to be explained, according to M. Perrier, by supposing that this species, like *Ascaris nigrovenosa*, is a free-living form which passes into a parasitic stage.

A third way of explaining the affinities shown by certain parasitic genera to the free-living forms, is to be found in the similarity of conditions of life; in *D. Pleurochætæ*, for instance, living in the perivisceral cavity of *Pleurochæta*, which is freely open to the exterior by a series of large dorsal pores, as well as by the apertures of the generative organs, the conditions of life must be very much like those enjoyed by many free-living forms.

The following is a brief *resumé* of the characters in which *Dicelis Pleurochætæ* approaches the free-living forms:—The presence of a long caudal appendage in both male and female, the relative thickness of the cuticle, the cellular structure of the œsophagus, and the presence of three spicules in the male. In the structure of its generative organs, however, it conforms to the type usually found in the parasitic forms, but the female agrees with certain free Nematoids in producing but few eggs. Dr Cobbold, in a paper read before the Linnæan Society, on November 17, 1881, described a parasite of the ostrich (*Strongylus Douglasii*) which has this character, and it is worth while remarking that the two genera *Strongylus* and *Dicelis* are very closely allied.

Explanation of Plate.

Fig. 1. Posterior end of body of female, *D. Pleurochætæ*, × 200.

Fig. 2. Optical longitudinal section of chitinous cuticle in male; upper surface of body, × 540.

Fig. 3. Do.; lower surface, × 540.

Fig. 4. Head from ventral side showing the single "mouth papilla," × 540.

Fig. 5. Portion of tail of female, × 540.

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* Arch. de Zool. Exp., t. ix., 1881.

XX. *On* Sphenopteris crassa (*Lindley and Hutton*). By ROBERT KIDSTON, F.G.S. [Plate V.]

(Read 17th January 1883.)

Sphenopteris crassa, L. & H., Fossil Flora, pl. clx. (1835).
Adiantites pachyrrachis, Göppert, Die fossilen Farrnkräuter, p. 387 (1836).
Cyclopteris pachyrrachis, Unger, Synopsis Plantarum Fossilium, p. 56 (1845).
Cyclopteris adiantoides, Unger, Genera et Species Plantarum Fossilium, p. 100 (1850).
Adiantites crassus, Schimper, Traité de Paléontologie Végétale, vol. i., p. 425 (1869).
Sphenopteris Kiowitzensis, Stur, Die Culm-Flora, Band i., p. 32, pl. vi., fig. 8 (1875).
Calymmotheca Kiowitzensis, Stur, Die Culm-Flora, Band ii., p. 151 (1877).

Perhaps no fossil plant of equally rare occurrence has received so many names as the present species. More than half of the synonyms have been created by systematists who, differing in opinion as to the genus in which the plant should be placed, appear to have thought that, on its being removed from one genus to another, they were quite justified in also applying a new specific name.

Since this fern was described by Lindley and Hutton in 1835, and the publication of Schimper's "Traité de Paléontologie Végétale" in 1869-74, three different designations have been applied to it, in none of which was any trace of the original name preserved.

The first alteration was made by Göppert in his work "Die fossilen Farrnkräuter," where he classes *Sphenopteris crassa*, L. & H., with *Adiantites*, and gives it a new specific name (*pachyrrachis*), without assigning any reason for the change. At that time the sole example which appears to have been known to him was the original type specimen, as he only mentions Burdiehouse as its locality. Little excuse can be made for such total disregard of priority of name.

In 1845 Unger placed this fern in the genus *Cyclopteris*, and retained Göppert's specific name for the species. The same author five years later, in his "Genera et Species," altered the specific name to *adiantoides*, to avoid confusion, as another *Cyclopteris*, from the Lias, had been described under the name of *Cyclopteris pachyrrachis*.

No further change took place in the designation of this plant till 1869, when Schimper again placed it in the genus *Adiantites*, but restored the original specific name of *crassus*.

My attention was specially directed to this fern when going over the fossil plants in the Museum of Science and Art, Edinburgh. In the "Hugh Miller Collection" were two specimens from Burdiehouse, one of which agreed entirely with the description and figure of *Sphenopteris Kiowitzensis*, Stur; but on the lower part of the specimen were a few pinnules similar to those on the figure of *S. crassa*, L. & H.

From the original plate and description of Lindley and Hutton I could not, however, determine whether the plant described by Stur was a distinct species or only a more perfect specimen of *Sphenopteris crassa*.

On searching, I was successful in finding the type of *S. crassa*, L. & H., in the Museum in connection with the class of Geology in the University of Edinburgh, an examination of which at once showed that the specimens in the "Hugh Miller Collection," and the *S. Kiowitzensis*, Stur, belonged to *S. crassa*, L. & H.

The type specimen shows the lower part of a frond, the axis of which bifurcates about an inch above the base of the portion which has been preserved.

No pinnæ are borne on the rachis below the bifurcation; but on the left-hand side of the left arm of the fork three pinnæ are given off (Pl. V., Fig. 1). On the right-hand side of the same arm of the fork only one is produced; but below it we have two large cyclopteroid pinnules, which occupy an analogous position on the stem to that of the pinnæ.

On either side of the axis, below the bifurcation, large cyclopteroid pinnules are also situated, similar to those on the inner side of the left and on the remaining fragment of the right-hand arm of the bifurcation.

On the highest pinna, the form of the pinnules changes and assumes a rhomboidal outline, the margins being more or less deeply cleft.

The rachis shows little scars from which scales have probably fallen.

On the specimen in the "Hugh Miller Collection," one of the pinnæ towards the lower part of the fossil shows the

cyclopteroid pinnules; but on the greater portion of the specimen their form is rhomboidal (Pl. V., Fig. 2).

The last-mentioned pinnules are composed of a number of cuneate segments, united together in a fan-like manner, the central one being the longest, on either side of which the truncated apices of the segments give a dentate outline to the pinnule, which is broadest near its centre.

These must be regarded as the typical pinnules, the cyclopteroid pinnules only occurring towards the base of the frond.

The difference between these two forms of pinnules is so marked that, unless they had been observed on the same frond, one would scarcely imagine that they belonged to the same plant.

In the figure of this species in the "Fossil Flora," the dimorphic nature of the pinnules has not been brought out, though on the specimen it is distinctly shown on the uppermost pinna.

The plant which Stur has described under the name of *Sphenopteris Kiowitzensis* represents the middle part of a frond.

His specimen likewise shows a dichotomy of the main axis, as well as the dimorphic nature of the pinnules.

In referring to the affinities of his specimens, Stur says: "Our plant shows almost as near a relationship with *Sphenopteris crassa*, L. & H., from the Carboniferous Limestone of Burdiehouse. This has the rachis simple below, above bifurcated, and bears pinnules, which likewise decrease from above downwards (?).

"But in the English plant the lobulation is different, the lobes being much broader, and the divisions between them appearing, on the contrary, less deep."

The inaccuracies in Lindley and Hutton's figure, to which I have previously alluded, are sufficient to justify Stur in describing his plant as a new species.

In the second part of his "Culm-Flora," the author removes this fern from *Sphenopteris*, and places it in his new genus, *Calymmotheca*, the chief character of which is the many-valved sporangium—one of his species (*Calymmotheca minor*) in fact being, as already pointed out by Mr C. W. Peach, probably a small specimen of *Staphylopteris Peachii*, Balfour.*

* Peach, "On Fossil Plants from the Calciferous Sandstone around Edinburgh" (Trans. Bot. Soc., vol. xiii., 1877).

As the fruit of *Sphenopteris crassa* is unknown, there is no evidence that it belongs to the genus *Calymmotheca*, Stur; hence I retain it in the genus *Sphenopteris*.

From the examination of specimens of *Sphenopteris crassa*, L. & H., which have come under my notice, I would propose the following description of the species:

Sphenopteris crassa, L. & H.

Main axis dichotomous, and marked with small transverse scale-scars. Frond tripinnate (?); pinnæ alternate, linear lanceolate; pinnules alternate, those towards the lower portion of the frond cyclopteroid and sessile, more or less deeply laciniate, the upper pinnules rhomboidal, broadest towards their centre, and narrowing into a short stalk at their basal extremity, apex truncate, margins more or less deeply notched; veins springing from the base of the pinnule and extending to the margins, numerous and frequently dichotomising.

Position and Localities. From the Calciferous Sandstone series: Burdiehouse, near Edinburgh; Straiton Brickworks, Loanhead (*Mr J. Gibson*); and Kilmundy Limestone Quarry, near Burntisland (collected by *Mr J. Bennie*, fossil-collector to the Geological Survey of Scotland).

My thanks are due to Professor Archer for permission to describe and figure the specimen in the "Hugh Miller Collection," Museum of Science and Art, Edinburgh, and to Dr A. Geikie, Director-General of the Geological Survey of Great Britain, and Professor J. Geikie, of the University of Edinburgh, for the use of the specimens in their custody.*

EXPLANATION OF PLATE V.

Sphenopteris crassa, L. & H.

Fig. 1. Type specimen of the species. From Burdiehouse, near Edinburgh.

Fig. 2. Larger of the two specimens in the "Hugh Miller Collection," Museum of Science and Art, Edinburgh; also from Burdiehouse.

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* *15th May* 1883.—When on a recent visit to Newcastle, Mr House, Curator of the Natural History Museum, called my attention to the original of Lindley and Hutton's *Sphenopteris linearis*. This is not the *Sph. linearis* (Brong.), but an exceedingly fine specimen of the upper portion of *Sphenopteris crassa* (L. & H.). The Plate is not a satisfactory rendering of the specimen. The following synonym must therefore be added to those already mentioned at the commencement of this paper:—*Sphenopteris linearis* (Lindley and Hutton), Fossil Flora.—Plate 230.

XXI. *On the Introduction of Reeves's Pheasant into Scottish Game Preserves.* By ROBERT GRAY, Esq.

(Read 20th December 1882.)

ABSTRACT.

Mr Gray, the Secretary, drew the attention of the meeting to two specimens of Reeves's pheasant (*Syrmaticus Reevesii*), which, through the courtesy of Lord Balfour of Burleigh, he was enabled to exhibit, and read some very interesting notes by Lord Balfour on the occurrence of this beautiful bird in a wild or comparatively wild state in various British localities, but principally in Scotland. During the past eight years Reeves's pheasants had been flying about wild in the woods of Guisichan in the northern half of the county of Inverness, the property of Sir Dudley Marjoribanks, now Lord Tweedmouth. More than one hundred had been shot there in the course of a single season, and the birds were found to be as hardy as (the young indeed more so than) the commoner varieties of pheasant. In the wilds of that part of Scotland the wandering propensities of the species were shown by the circumstance that many of the birds had already found their way many miles over the open hills to Balmacara. It was also stated that forty male birds had been turned loose in the woods of Tulliallan, Clackmannanshire, and that one of them, which was identified by Lord Balfour, had been accidentally shot. No hybridous eggs, however, had resulted from this experiment. The two birds exhibited had lived in a wild state along with others of the same species for six years at Elvedon estate in Suffolk belonging to the Maharajah Duleep Singh, and were shot there by Lord Balfour in October last, the proprietor having yielded to the wish of his keeper that the birds should be killed on account of their pugnacity. Several hybrids had appeared during these years in the Elvedon grounds. They were dark-coloured birds, heavier than either parent, and with a white head and neck.

Mr Gray observed that from the readiness with which this beautiful pheasant seemed to adapt itself to our northern preserves, it was not too much to expect that in a very few years it would become thoroughly naturalised, and be found in considerable numbers all over the country.

XXII. *Note on the Occurrence of* Lithobius variegatus (*Leach*) *in Scotland.* By T. D. Gibson-Carmichael, Esq.

(Read 20th December 1882.)

This species is the only myriopod as yet known which has not been found out of the British Isles. Leach, in his description of the species in the eleventh volume of the *Transactions of the Linnean Society*, says of it, "habitat in Danmonia australi sub lapidibus passim." Newport (*id.*, vol. xix., p. 363) says of it, "Habitat in Wimbledon common prope Londinum," and mentions a specimen of the species in the collection in the British Museum, ticketed in Leach's handwriting "Ireland," though Leach had wrongly labelled this specimen *L. forficatus.*

This summer I have obtained specimens of *L. variegatus* from various localities in Scotland. Mr Gibson collected numerous specimens in Colonsay. I myself found it frequent in the woods at Inverary, and rare in the neighbourhood of Loch Katrine. I have also received it from near Oban, from Kirkcudbrightshire, and from the neighbourhood of Bowling in Dumbartonshire. The species seems thus to occur throughout the west of Scotland. No specimens have yet occurred among the material which I have received from various places in the east.

I have also obtained it in several new localities in England —at Clifton (Bristol), at Chatsworth in Derbyshire, and near Wimborne in Dorsetshire. I have always found it under or near oak trees.

XXIII. *On the Occurrence of the Pectoral Sandpiper* (Tringa maculata, *Vieill.*) *at Loch Lomond.* By Robert Gray, Esq.

(Read 20th December 1882.)

The specimen of this bird now on the table was shot on 28th of last month on the banks of Loch Lomond by Sir George Leith Buchanan. It rose along with several snipe from a strip of marshy ground frequented by these birds, but did not seem to be accompanied by others of its own species.

The bird is a female, and on dissection its stomach was found to contain the remains of beetles, etc.

The pectoral sandpiper, or *Jacksnipe* of American authors, is well known to sportsmen on the other side of the Atlantic, and, according to Dr Elliot Coues, is frequently sought after both on account of its habit of lying till flushed like a true snipe and of its being an excellent bird for the table. It is found in considerable numbers throughout the United States, where, however, according to the author just named, it is chiefly, if not entirely, a bird of passage. It is very abundant in summer in Labrador, where it frequents muddy flats and salt marshes.

Audubon states that, like the snipe, this sandpiper is partial to damp meadows and marshes, and refers to the fact that, unlike other sandpipers, it does not gather in flocks to any extent, but is found for the most part singly or in pairs. According to Professor Kümlein, it breeds abundantly in Wisconsin; and Professor Reinhardt mentions that it has occurred in three instances in Greenland. The species is likewise found in Central and South America and the West Indies, and Captain Blakiston includes it in his list of the birds of Northern Japan.

In Great Britain about twenty specimens altogether have been obtained, but, so far as I am aware, this specimen from Loch Lomond is but the second example that has occurred in Scotland, the first having been met with at Donmouth, Aberdeen, on 2d October 1867.

I am indebted to Mr Small, George Street, for an opportunity of exhibiting the bird, and I have pleasure in drawing attention to it as an interesting addition to our ornithological records for the present year.

XXIV. *On the Stockdove* (Columba œnas), *with Remarks upon its Extension of Range in Great Britain.* By J. A. Harvie-Brown, Esq.

(Read 21st February 1883.)

Amongst many natural phenomena worthy of our notice in the life history and habits of animals, not the least interest-

ing are those connected with the laws of the extension of range in the breeding season, and closely allied to these, and in part dependent upon them, the laws of migration, and the distribution of species at different seasons.

If, for instance, a species of bird appears with tolerable regularity and in yearly increasing numbers during the autumn migration or winter season at a locality, or in a district where it had never been seen before, it is perhaps natural to suppose that this distribution is due to a greater extension of the breeding area. If, however, these occurrences are only fitful, and not steady or increasing in numbers yearly, a more natural supposition perhaps is that they are due, not to a steady increase in breeding range, but to abnormal winds occurring at the time of migration.

It is quite true, however, that in many cases such phenomenal "rushes" of birds at long intervals upon our coasts can be traced to an overflow at their headquarters, and such there is every reason to believe was the cause of the vast irruption of Pallas' Sand Grouse into Europe from the Siberian plains in 1863.

It is not my purpose here to go into the subject of all the causes affecting the spread of species in the nesting season, as such an inquiry would form materials for a separate essay of no mean proportions, but certain causes will readily suggest themselves to you, as I speak of the actual facts of the extension of range of the present species—the stockdove (*Columba œnas*, Lin.).

The specimen I show you this evening was obtained at Gartmore in the south-west of Perthshire, and was forwarded for me to Mr Small, George Street, by Mr C. C. Tunnard, factor on Gartmore. It was obtained on the 1st January 1883, and since then he is almost certain he has seen more.

The following notes have no pretensions to exhaustiveness, but are intended merely to indicate the general lines. They might as it were form a framework for a more exhaustive account of the species and its travels.

Of the distribution of the stockdove on the continent of Europe, and of the probable prehistoric land-connection between our south-eastern counties of England and Holland, I

will merely record in passing that, though abundant in Germany and in a somewhat broad belt across Central Europe, the stockdove is at present rare in Holland. Though this may be the case in Holland at present, I believe that when that country was under a different climate and different vegetable growth, say perhaps in the time of our old Norfolk forest beds, the stockdove was in all probability more abundant there, and that we derived our stock by that natural land-connection. Going back as far as my knowledge and the literature at my command permits, I find that in the south-east counties of England evidence of the species occurring is never wanting. Even as far back as the date of the Privy Purse Accounts of the Lestranges of Hunstanton (viz., 1519–1578), mention was made of them, and I cannot find anywhere that the stockdove appeared in these counties suddenly or unexpectedly. Therefore, as far as Great Britain is concerned, these south-eastern counties must be taken as the cradle of the race, just as for many years they continued to be its headquarters, though now, or in recent years, a diminution appears to have taken place at the old centres in accordance with a natural law. My friend, Mr J. H. Gurney, jun., instances this decrease, and considers it as very strongly shown by the small percentage of stockdoves killed amongst wood pigeons. Near Northrepps, as he informs me, the "gamekeeper has taken seventy-two wood pigeons in the last five weeks (*in lit.* 10th February 1883), and not a stockdove amongst them." "This," Mr Gurney continues, "is an unanswerable proof of their scarcity." Since then he has informed me of two stockdoves near Northrepps, one of which he captured alive. Whether this scarcity is permanent throughout the year, or is owing to partial emigration in winter from that part or from the whole of that county, I have not as yet ascertained with sufficient certainty. That a very considerable migration does take place during the winter months is, I think, quite certain, as Mr Stevenson has pointed out in his "Birds of Norfolk" (*op. cit.*, vol. i., p. 355), and that author also mentions the scarcity of the species around Norwich. For my own part, I certainly believe that at one time it was not migratory there to the same extent, but that the migratory instinct has

been developed of late years, or since the numbers increased to overflowing, according to a natural law. "I cannot doubt," says Professor Newton (*in lit.*), "that the stockdove has been an inhabitant of the heathy part of Norfolk and Suffolk from prehistoric times. Before rabbits were introduced, it probably bred under the thick furze bushes, in the way that it occasionally does now, but the introduction of the rabbit must have been a great benefit to it, as it then had safer lodging for its eggs and young." *

Amongst our earlier natural history works on the birds of Great Britain, we find that Hewetson, in 1856, records that though the stockdove is rarely met with in the North of England, it breeds in some of the southern counties, and it is not uncommon in Epping Forest. We do not for present purposes, I think, require to go further back in its history in these south-eastern counties.

Coming down to the year 1865, we find Mr A. G. More gives concisely the typical distribution of the species, and records it as most abundant in some of the midland and eastern counties of England; but, he tells us, "it has not been observed in either Scotland or Ireland." He adds—"While it appears chiefly as a winter visitant in the south-western counties and even in Dorset, it still has been known to breed in Gloucester, Hereford, and Shropshire, and perhaps in North Wales;" and at the time Mr More wrote (1865) the nest had been found in east and west Yorkshire, but hardly beyond the 54th degree of north latitude. All Mr More's notes point to the headquarters as still being in the eastern and south-eastern counties.

Appended is a list of the English counties wherein the stockdove was known to breed up to the year 1864. This is supplemented by the list of other counties where it has been

* A considerable confusion existed amongst early British naturalists as to the specific values of the stockdove and of the rockdove (*C. livia*). This is lucidly explained in Eyton's "Rarer British Birds," 1836, p. 27. We do not, however, think that this confusion appreciably affects the trustworthiness of our earlier records in the south-eastern counties. Many years ago I have had evidence of so-called wood-pigeons breeding under furze bushes on Tents Muir in Fifeshire. As yet I have failed to learn if these were really wood-pigeons or *C. œnas*.

recorded to have bred *since* 1864 and up to 1881, and it will be seen that these are geographically grouped in this list, in order to assist our conception of the spread and increase:—

Previous to and including 1864.

SOUTH-EAST.	EAST.	CENTRAL.	WEST.
Kent.	Essex.	Oxford.	Dorset.
Sussex.	Suffolk.	Warwick.	Wilts.
Surrey (occ.).	Norfolk.	Northampton.	Gloucester.
Hants.	Cambridge.	Leicester.	Hereford.
Middlesex (occ.).	Herts.		Shropshire.
	Huntingdon.		Stafford.
	Bucks.		Derby.
	Lincolnshire.		Cheshire.
	Yorkshire.		Lancashire.

For the above I am indebted to Mr A. G. More, who is now preparing a new paper on the subject of the distribution of British birds in the nesting season. He tells me that to the above have been added since 1864 the following:—

SOUTH-EAST.	WEST.
Isle of Wight, 1873, *auct.* C. R. Bury.	Merioneth, 1873, *auct.* T. Ruddy.
	Denbigh, 1875, *auct.* W. J. Kerr, and 1881, *auct.* C. G. Beale.
	*Cumberland, 1881, *auct.* W. Duckworth.†

To the above list of English counties we have also to add all the occurrences across the Border on the Scottish side, which are given further on, showing the steady flow of the species towards the north. It is of course extremely probable that in some places the species has been overlooked for a few years, but we cannot think that this has been the case in all localities, nor that the species can have existed for any great

* In Cumberland one w[illegible] ars ago.

† I have Mr T. D[illegible] be seen further on, of its nesting as earl[illegible]

length of time in such counties as Berwickshire, Perthshire, or the south-west of Scotland without coming under the notice of capable naturalists.

But to return. Later, in 1872, Harting ("Handbook of British Birds," p. 36) arrives at similar conclusions, and summarising the writings of previous authorities, he states the case somewhat thus:—The stockdove is common and resident in Norfolk, Leicestershire, Shropshire (compare here with Mr A. G. More's less comprehensive "has been known to breed in Shropshire"); resident in Bucks and Berks; Middlesex, where, however, it is more common in autumn and winter; resident and common in New Forest and Sussex, but rare in Somerset and in Cornwall, * and a winter visitant in Devon; rare winter visitor in Isle of Wight, and twice obtained in Scilly.

From these and other sources too numerous to refer to in this place we glean in a general and tolerably accurate way that its home and probable birth-place, as far as England is concerned, is in the south-eastern counties; second, that it migrates to some extent, but not wholly, west and south in autumn and winter from this centre; and we have still to show in the remaining part of this essay the progressive steps of another advance—the most important of all—in a northerly direction, whilst extending the area of its distribution during the nesting season. The probable result of this will be the development of a more strongly-marked migratory instinct to the south and west of its more northerly breeding distribution. If a latent or embryonic degree of the impulse actually occurs from its centre or birth-place, it is reasonable to conclude that as it reaches northwards this instinct will be developed still more.

The stockdoves came first to the south-east coast of Lincolnshire, as I am informed by Mr C. C. Tunnard, in either 1863 or 1864, and it increased rapidly. At the present time one may see flocks of thirty, but they generally fly in parties of eights and tens. Mr Tunnard adds that they appeared near York a few years afterwards, and now breed round that

* Hearle Rodd ("Birds of Cornwall"), however, speaks of large flocks being occasionally seen during the winter months.

locality regularly. "They come," says Mr Tunnard, "to the roost with the wood pigeons, but actually roost close together, and apart from the other species. Up to 1863 there was not one with us in south-east Lincolnshire. A person may mistake them if flying about, but no one can mistake the 'coo' where they are breeding. In 1872 or 1873," Mr Tunnard continues, "I saw a stockdove my brother-in-law had just shot in the north of Ireland—co. Donegal."

In the north-east and north-west of Lincolnshire Mr Cordeaux writes me "that the stockdove thirty years ago was rare in the north-east of Lincolnshire, but not uncommon in the warrens and commons in the north-west corner of the county. It is now very common in the north-east. It breeds annually in some numbers in holes in the sea cliffs of Flamborough, and I am sure this was not the case ten years ago."* Mr Cordeaux adds concerning the birds at Flamboro' Cliffs:—"I have seen them myself fly out of fissures in the chalk cliffs, as well as from the fine rabbit burrows in the shelving mass of boulder clay, thirty feet in thickness, which caps the chalk." The rockdoves nest only in the caves of the cliff bottom, whereas these stockdoves nest high up, as above explained. The eastern form of rockdove found in India—*C. schimperi* (Baily)—closely resembles the rockdove, and from the grey rump also closely resembles the true stockdove. I have a specimen here of a dove shot in Égypt by Mr J. H. Gurney, and kindly lent me for exhibition. This seems to me to partake of the characteristics of the true rockdove and also of those of the Indian *C. schimperi*, the rump being not so white as in *C. livia*, but whiter than in *C. schimperi* from India. Not having an Indian specimen, however, at hand to compare with, I speak with reservation on this point. Yet as far as I can recollect, specimens of *C. schimperi (vera.)* are uniform grey, without *any* white on the rump.

In Durham the stockdove appears to have been first re-

* Mr Cordeaux adds that in the same way "many species once unknown here are working their way northwards; for instance, in Lincolnshire—the Dartford warbler, blackstart (*S* … irl-bunting (very common in one locality), turtle dove … ting at some future date, perhaps, to r… …t other localities in their advance

corded in 1869, when one was shot in Castle Eden Dene on 26th October 1869, and its nest found. It was also found breeding in 1870, and one bird was caught; and again in 1871, when Mr Slater found the nest. In 1872 Mr Slater records that, owing to protection afterwards afforded to it by Mr Burdon, it was multiplying very rapidly. In 1873 it appeared at Hexham, and in 1874 at Ravensworth, where several pairs were seen. This brings the records up to the date of Hancock's "Birds of Northumberland and Durham," viz., eighteen.

"Only a month ago," says Mr Cordeaux, however (*in lit.* 12th January 1883), "I received from a friend a stockdove shot the day previously when driving some large woods in Durham, with a request that I would say what it was. So this does not look as if it was very common in 1882 in the interior of the county."

In Yorkshire Mr W. Eagle Clark takes up the thread as follows:—"I have gone into all the information I have accumulated regarding the stockdove as a Yorkshire bird. I find that very little indeed has been recorded in the natural history periodicals on its wonderful increase in numbers during the last half-century, and nearly all the information I give you is derived from the lists I sent out prior to preparing the sketch on the birds of this county contained in the handbook.

"The first notice of the stockdove appears to be that of Mr Thomas Allis, who in his report on Yorkshire birds, read at the British Association at York in 1844 (in the preparation of which he was assisted by the then Yorkshire ornithologists), says that he himself has only seen one Yorkshire specimen, that in the York Museum, which was shot near the city, but that Mr Chapman had seen two or three exposed for sale in York market in the winter of 1843, and that Mr Happenstall informed him that it was not unfrequent near Sheffield. In 1877 a correspondent writes in the *Field* about its sudden increase near York, but I have been unable to consult a file of that journal. Now, this species is generally distributed in the Vale of York, and breeds in holes in hedgerow trees, etc. In 1844 it is noted as not being observed near Barnsley,

in South Yorkshire, but is now not uncommon but local. In 1865 it is described as 'rarely visiting' the neighbourhood of Beverley in East Yorkshire, and the occurrence of a flock there in the winter of 1864 and the shooting of a single male (one of a pair) in March 1865 is considered worthy of a communication in the *Zoologist.* Now, the recorder of the above fact informs me it is common, and breeds.

"Another correspondent in East Yorkshire tells me that it has much increased in numbers during the last twenty years. In the cliffs at Flamborough, where it now breeds in numbers, I am told there were but few ten or twelve years before (1881). At Slingsby, near Malton, in north-east Yorkshire, it is described as only having established itself twelve or fifteen years prior to 1881 (1866 or 1869), and before that date only a few had occurred in that neighbourhood; now they are abundant, and perhaps less numerous in winter.

"In the western portion of the county it is only given as occurring in a few of the lists received from my correspondents. In the extreme west, about Slaidburn, it only made its appearance for the first time 'a few years ago,' and now a few pairs breed every season. It is included in the lists received from Halifax and Bingley in the southern and central portions of western Yorkshire, but not in any list from the north-west. It is also omitted from a list by a valued correspondent in Huddersfield, which is singular, since it is recorded for Halifax.

"In all the lists received from southern, central, eastern, north-central, and north-eastern portions of the county it is included as a resident without comment, except in those from which I have quoted. Some observers refer to it as being less numerous in winter.

"The above is a *rough* but accurate sketch of its Yorkshire distribution, based on the material now in my possession. I could easily obtain further and more detailed particulars on applying to my correspondents, and if you are sufficiently interested in this problem, and care to pursue it further, you may rely on me for most willing and hearty co-operation.

"I have no information other than that contained in books on its increase in other northern counties or Lincolnshire, but

regarding the latter county I will give you the information contained in a note in the *Field* for June 2d, 1877, wherein 'Punt Gun' says:—'Some eight years or so ago the stock-dove was, to the best of my belief, almost unknown in the neighbourhood of Boston. . . . Now it is not at all uncommon to see small flocks of a dozen or so, either by themselves, or feeding with the common wood pigeon. They breed there regularly.'" *

In Lancashire I learn it is quite abundant, breeding along the whole stretch of sandy coast between the mouth of the Dee and Walney Island, as I am informed by my friend, Mr F. S. Mitchell of Clitheroe, who is at present engaged in preparing a handbook of the birds of Lancashire. He adds, "It has been known to nest in the neighbourhood of Blackstone Edge, near Rochdale, but is rare there. It also breeds near Garstang, and has nested near Accrington within the last four or five years. It has been seen near some rocks on the lower slopes of Pendle Hill, near Clitheroe within the same time, but no nest was found, and it appeared also on the banks of the Hodder where that river divides Lancashire from Yorkshire, at which locality there were also several pairs in 1882."

In Cumberland Mr W. Kensey Dover, of Keswick, writing to Mr T. Duckworth regarding this species, says:—"About twenty-five years ago W. Greenup, of Keswick, found the nest of the stockdove in an old tree root, which had been blown over, on the west side of Bassenthwaite Lake." Mr T. Duckworth adds that this is the first record of the bird he knows of in this county (*in lit.* February 18th, 1883). Previous

* Since the above was penned, I have instituted further inquiries into the range and spread of the stockdove in Yorkshire, with the chief result that I am informed, on the reliable authority of Mr Boyes, that warreners now alive remember this bird being numerous on the Wolds *sixty years ago*, when it was their perquisite. Thus it is a most interesting fact that at a period when the stockdove was almost, if not quite, unknown elsewhere in the county, it was common on the vast Wolds of the East Riding. I am inclined to think that Yorkshire, and other neighbouring counties, have been peopled with stockdoves from this source; for with the gradual enclosure and cultivation of these great warrens, we find a simultaneous and equally gradual spread of this species has taken place.

to this, Dr Heysham, writing in Hutcheson's "History of Cumberland," 1795, was doubtful of its occurrence in the county (*vide* "Life of John Heysham, M.D.," by Henry Lonsdale, M.D., 1870; 53 pages of the fauna). Dr Heysham wrote in 1795. Mr Duckworth has had considerable acquaintance with the species of later years around Carlisle within a radius of some eighteen miles of the city. He writes, "In the Rose Holms, west of Carlisle, about six miles from this city, on the 28th of April 1861, in an old oak tree (one of the last vestiges of Inglewood Forest), I found the first nest of the stockdove, and in the following year I found another in an old rabbit-hole in the bank of the river Roe, a tributary of the river Calden. Since that time they have spread considerably, not in great numbers, but in different parts of the district. I have found them on the banks of the river Lyne, about seven miles north-east of here, also on the Newbiggin Holms by the side of the river Petterill, about five miles south of here, and others by the river Eden, in holes in rocks, south-east from here. I have found them near rivers in every instance."

SCOTLAND.

In Scotland, we find an early record comes from a considerably northern county, viz., Perthshire. Mr A. B. Brooks writes me as follows: "I first observed the stockdove seven or eight years ago—say 1875 or 1874—when one flew close past me one day in spring (I have not the exact date); but for some time I could not find their nest, and it was not until 1878 that I succeeded in doing so. I sent a note of this to the *Ibis*, 1879, p. 112. I took one of the young birds from this nest, but it escaped out of the cage after I had kept it about a fortnight. In 1879 I was delighted to see the old pair back again, and they again bred in the same rocks, about fifty yards from the site of the old nest, and brought out their young ones, one of which I took when fully fledged and sent to the Zoological Gardens in London, and it was alive and well a couple of months ago. I have been away from home since that every summer, but have very little doubt of their breeding in the same place if they have escaped being massacred. Their nest, as mentioned i[illegible] t,

in a rocky face of a hill, about, I should think, 1000 feet above the level of the sea, in a hole under some rank heather, or what was very like a rabbit's old seat."

Mr J. J. Dalgleish recorded the occurrence of this species in the Culross or southern district of Perthshire, "a detached and purely lowland portion of that county." He goes on to say: "The first was shot at Tulliallan by Mr Millar, gamekeeper there, on the 27th of last month (?); and the other"—which was the bird exhibited to this Society—"was shot on my property of West Grange, in the parish of Culross," by Mr John Livingstone, gamekeeper. The former has, I believe, been presented to the Museum of the Alloa Society of Natural Science" (*Proc. Roy. Phys. Soc.*, 1876-1878, p. 288).

In Perthshire, also, Colonel Drummond Hay, in his "Notes on the Birds of the Basin of the Tay," 1879-80, p. 33, instances several obtained in, or prior to, 1878, including those nesting, as recorded by Mr Brooke of Cardney, a bird seen by himself in the Carse o' Gowrie, probably breeding in the Glencarse or Balthayoch rocks, and the two examples obtained in the southern part of Perthshire in 1878, as recorded above by Mr Dalgleish. I have since learned, however, that in 1880 and 1881 these birds came in immense quantities to the Carse o' Gowrie in spring—say middle of April—but in 1882 they were very scarce (*in. lit.*, G. H. Baxter to Mr Cook, 1883).

In the next instance, Mr Robert Gray brought before the notice of this Society the occurrence of the stockdove in Berwickshire (*Proc. Roy. Phys. Soc.*, 1878-79, p. 131), and in 1881 the bushy lime tree, in which a nest of this species was found, was pointed out to myself by Mr Waitt, the birdstuffer of Duns. It is a lime tree with a thick, dense growth of suckers in the centre, of which there are several similar ones in the policies near the castle. By Mr Gray's account, the species must have bred for several years in that county, but we have no earlier records that I am aware of. More than a dozen were seen on the 11th March 1879, on which day a specimen was procured for Mr Gray. At the same time they are reported as "increasing every year in numbers," migrating in severe weather to the coast, but invariably returning again

in milder weather. It must be considered a resident, no less than five nests having been known to exist on Middleton Estate, Belford, in 1880 (*auct.* John Aitchison, *Proc. Berw. Nat. Field Club*, 1881, p. 562).

That this species has occurred and does occur at the present time in Scotland in much larger numbers than have been reported, I think there can be scarcely any doubt. It is lack of observation, not lack of specimens, that is to blame for an imperfect sequence of occurrences, *say* between 1875 and the present time. Hundreds of "Norwegian pigeons" and wood pigeons are killed every year in the eastern counties of Scotland, both in spring and autumn; and the question naturally arises, how many of these, taken perhaps on a superficial examination as young wood pigeons, might not really have proved to be, on more careful inspection, specimens of the stockdove? I believe the stockdove to be at present a much more common species in Scotland than is generally supposed, and much more widely distributed; and this could be easily, I believe, ascertained if any competent ornithologist would make a point of examining the great numbers which crowd the markets in spring and autumn. At the same time, its progress northwards, and its increasing extension, are none the less certain, and distinctly traceable, though many of the links in the chain of evidence have been, so to speak, imperfectly forged.

In Dumfriesshire and the south-west of Scotland the stockdove appears to have been a breeding species for several years at all events, if not for a much longer period. Mr J. J. Armistead has met with it breeding in Kirkcudbrightshire, and has noticed that a few of these birds have visited the Colvend shores annually, and frequent the cliffs. Mr Armistead has seen them himself for the past three years, and he relates that the natives say that they have always bred along shore (the natives call them rockdoves, but the bird is *Columba œnas*, with which Mr Armistead is perfectly familiar). Mr Armistead has also met with them in Cumberland, where he has known them to breed in rabbit-holes among the sandhills on the Cumberland shore. They do not appear to pass far inland.

And now, we have to record first, its occurrence at Gartmore in the south-west of Perthshire, in the lovely Vale of Menteith, on the 15th January 1883, as proved by the specimen shown to you to-night; second, a later occurrence on the 14th March, at a locality about seven miles further east in the same Vale of Menteith; and third, the breeding of the species at the last noticed locality, and the discovery of the fact by James Stirling, Esq. of Garden. The bird was sitting hard on the 14th April 1883. The eggs were laid amongst a few dry leaves on the otherwise bare earth of a rabbit scrape under an ash-stump, and about 3 feet from the entrance of the hole.

In conclusion, I may be allowed to point a moral.

I think that the subject of the extension of range and the increase of species is always of great interest, affecting the life history in many other important matters of detail; and writers upon our own British birds, or on British Zoology, would do well to pay special attention to such developments. Migration is induced, and the great laws of migration are actually brought into being by such increase; if anything be done to retard or check the natural outflow or extension of range, distress, poverty, and death follow.

The moral is, that it does seem strange that of all living creatures, *Man* is the last, and the most reluctant to yield to, and the slowest to realise, these facts; and day after day, year after year, he sets at defiance these great natural laws, until it culminates in the state of things we at this present time hear of in our own Western Isles and in Ireland. Certainly the only sensible, the only really efficacious way, from a naturalist's point of view, of relieving districts overcrowded with human life, is to open out fresh ground and to assist and encourage emigration, to plant the Saxon on wider areas and virgin soil, where the natural vigour of the race—long dormant, whilst hopeless crowding and exhausted land had sapped their energy and lowered their moral tone—would quickly again reassert itself, and great good to them would assuredly follow, as it has done many a time before.

XXV. *Notes on some Ethnographical Specimens brought from the Nicobar Islands by Colonel Cadell, V.C., Chief Commissioner of the Andaman and Nicobar Islands.* By A. Galletly, Esq.

(Read 15th November 1882.)

The Nicobar Islands are situated in the Bay of Bengal about 1000 miles nearly due south of Calcutta, and the largest island of the group, called the Great Nicobar, is not greatly larger than Arran at the mouth of the Clyde, and like it very mountainous.

In this communication a brief account was given of Colonel Cadell's visit to the Great Nicobar in March 1881, when, along with Mr F. A. de Roepstorff, a member of his staff, he succeeded in penetrating five miles inland from a point on its northern shore. The main object of the journey was to visit the wild tribe called Shompengs living in the interior of the island, about whom almost nothing had been previously known, as they are very shy of holding any communication with the shore inhabitants. The travellers saw seven of these Shompengs in their mountain homes, and in Mr de Roepstorff's account of the journey, he states that he considers them to be of a different race from the shore inhabitants, but that they are identical with the people of Chowra, one of the smaller islands of the group.

In the following list a brief description is given of the ethnographical specimens shown, which have been kindly presented by Colonel Cadell to the Museum of Science and Art, Edinburgh.

1. Shompeng cooking vessel, formed of the bark of a tree, and the only one of its kind which has yet been brought to Europe. From its very primitive character, this is an extremely interesting object. It is of very rude construction, but this specimen is not exceptionally so, as two or three others very similar to it were seen. The bark, which is smooth and about one-eighth of an inch thick, is simply folded into a kind of boat shape, each of the ends being

pressed together between two supporting sticks, and closed up completely with clay. To keep the ends still better secured against opening, a wooden pin is driven through the two thicknesses of bark at each end. The vessel so formed is 2 ft. 6 in. in length, 8 in. in width at the centre where it is most bulged, and 6 in. deep. Each pair of the four sticks forming its supports, is tied together. The lower ends of these are stuck in the ground, and they are about 4 ft. in total height, but the bottom of the cooking vessel is barely 18 in. from the ground. It has internally a strip of wood lengthwise on bottom, and three or four cross ribs formed of twigs to keep it from shrinking. Externally it is a good deal charred, and so are two of the supports. It is uncertain what kind of food is cooked in these vessels, but the shells of fresh-water mussels were found lying about around the huts. The bark has nothing in its composition specially fitting it for withstanding heat, as its ash is composed of alkaline carbonates, and it will char and get brittle at the same temperature as many other barks. Just as water can be boiled in paper over a gas-flame if the paper be covered with water where the heated air strikes it, so, perhaps, the fibre of this bark is such as to retain moisture and conduct heat after it has become well soaked in water. In this way, when containing liquid, it would stand for a time the heat of a fire just as a paper vessel filled with water does that of a lamp or gas jet. Cooking vessels, even of wood, are rare among savage tribes. The natives of Vancouver Island appear to have used them, and it is rather singular that in the neighbouring group of islands to the Nicobars, the Andamanese have a method of cooking food in a bamboo vessel. A cell of the bamboo containing the food is placed on a fire and constantly turned so that all parts are equally exposed to the heat. The vessel is only capable of being used once, and the food is taken out by splitting it. The bamboo has a solid siliceous substance in the joints of the stem which probably helps it to withstand the action of the fire.

2. An earthenware cooking pot of a reddish colour and coated on the outside with some kind of varnish. It is circular in shape, with straight sides and a hemispherical bottom; and

its size is 9 in. in diameter and 7 in. deep; but some of these pots are rather larger. The only ornament is on the outside, and is of the simplest kind, consisting of a dark band round the lip, from which about six broad stripes, also of a darker colour than the ground, run down the sides. The thickness of the ware is about a quarter of an inch, and though a little coarse it is yet made with some degree of skill. These cooking vessels are made at Chowra, one of the smaller islands, the natives of which are potters for the whole group of the Nicobars. It is a curious illustration of how little intercourse there is between the Shompengs and the shore inhabitants, to find the former using rude cooking vessels made of bark when far more serviceable ones of pottery could be so easily obtained.

3. Pair of water-holders, each formed of a cocoa-nut shell, blackened and polished. These are prepared by a tedious process of applying pig's fat, then smoking over the fire, and finally hand polishing. The broad end of the shell is perforated with two small holes, which enables two nuts to be tied together with a piece of plaited fibre. These water-holders are not easily obtained from the natives, on account of the patience and labour bestowed on the preparation of them.

4. Wooden cross-bow and arrow of very light construction, the only metal portion being the head of the arrow. Similar cross-bows are used in Assam, and also on the Martaban coast, in Pegu, by the Kairen tribe. This form of weapon is known to be likewise employed by a tribe on the West Coast of Africa. It is curious to find an arm not differing much from the type of the European cross-bow of the Middle Ages still in use among several widely separated savage tribes.

5. Head of a fishing spear entirely made of wood. The projecting centre point is formed on the end of the shaft, and around this there are about a dozen spreading prongs tied at their base around the shaft. These are all rudely barbed. The shaft measured 10 or 12 ft. in length.

6. Headpiece made from the husk of a cocoa-nut, round which a thick cord of the same fibre is wound and held on by

a kind of network of smaller cord. This rude helmet is used for playing singlestick in the Island of Chowra.

7. Human image holding a spear carved in wood. This is a charm for frightening away evil spirits. It is only 13 in. high, but similar figures, life-size, represented in the act of striking with a spear, are often to be seen at the entrances of native huts.

8. Two miniature human figures, rudely carved in wood, and smeared with yellow and vermilion: also figures of a dog and a pig carved in wood, but displaying little art. These are partially smeared with vermilion only on the bare wood.

9. Bark of a species of *Celtis* (Ulmaceæ), prepared for use as clothing by the natives.

10. Model of a Nicobarese hut. It is of bee-hive shape, elliptical in plan, and supported on posts. The floor is from 7 to 10 ft. from the ground and is reached by a ladder, but there is a lower platform which is used as a store-house for food, hen-coops, etc. These huts are situated near the high-water line, and suggest a comparison with the ancient lake-dwellings of Switzerland and other countries.

XXVI. *Obituary Notice of Sir C. Wyville Thomson, LL.D., F.R.S.* By GEORGE LESLIE, Esq., M.B., C.M.

(Read 15th November 1882.)

During this passing year biological science has lost some of its most devoted followers. Darwin and Francis Balfour, the Well-beloved, have finished their work. We have now to speak for a little of the completed life and achievement of a famous naturalist, who was long and intimately connected with this city and with this Society.

Charles Wyville Thomson was born on the 5th March 1830, at Bonsyde, Linlithgowshire, where the family had been long resident. Bonsyde, beautiful as to situation, with its varied prospect of palace, mountain, loch, and stormy firth, was a fitting home for the young nature-student, and it was, throughout his life, his much-loved haven.

He received his general education at Merchiston Castle in

this city. His favourite school studies were the writings of the Latin poets, of which he always retained a familiar and pleasure-giving knowledge. At the age of sixteen, he matriculated as a student of medicine in the University of Edinburgh, it being intended that he should follow his father's profession. From the beginning of his college life he devoted himself with enthusiasm to the sciences of botany, geology, and more especially of zoology. The study of the lower forms of marine life had already great attraction for him, and for this study he found abundant material in the rich fauna of the Firth of Forth. A solitary example of the Echinid, *Dorocidaris papillata,* almost the only representative in the College Museum at this time of the deeper water forms, exercised a special fascination over him. He contemplated the happiness of the man who should possess such a treasure.

As a student he did not belong to that class all of whose thoughts and studies are directed to the passing of examinations and to the attainment of degrees, little caring what the kind of knowledge they acquire may be, if its mastery is required of them. He was shrewdly suspected by these of devoting much time to work which they regarded as highly unprofitable. He was often found at the sea-shore curiously examining strange animals called Medusæ, or in the country watching some rare butterfly or bird, when they thought that his time had been better spent in poring over the text-book or syllabus of lectures. They did not foreknow that the shiftless Medusa studies were to culminate in giving to mankind the knowledge of the life of half the world, and to dower the favourite but somewhat commiserated student with an imperishable name.

He was elected a Fellow of the Royal Physical Society in his earlier student days, and we of this Society reflect with satisfaction, that its Fellowship was the first of the many distinctions which were conferred on him. He held for two years the office of secretary to the Society, taking a very active part in its scientific work and administration. His interest in its welfare continued unabated, although distance and the multifarious engagements of his later years prevented

him from taking a personal share in its proceedings. Its rejuvenescence and vigorous growth during the last decade gave him much gratification.

While at the University an attack of ill health induced him to abandon the medical profession, when he resolved to devote himself exclusively to the study and teaching of the natural sciences. At the age of twenty-one he was appointed to the Lectureship on Botany at King's College, Aberdeen, and a year later to the same office at Marischal College. In 1853 he was elected Professor of Natural History in Queen's College, Cork; in 1854, Professor of Mineralogy and Geology in Queen's College, Belfast; and in 1860 Professor of Botany and Zoology at the same College. During his residence in Belfast he gave a large part of his attention to the study of the lower forms of marine life, publishing numerous memoirs on the Hydrozoa, Polyzoa, and on kindred subjects. He also formed the excellent Museum of Natural History at Queen's College, to which he gave a large part of his own collections.

Sir Wyville Thomson was one of the first naturalists who believed in the existence of a varied fauna living at great oceanic depths, and who appreciated the importance of researches into its conditions. His convictions were strengthened by the dredgings of Absjörnsen in 200 fathoms, and of Sars in 300 fathoms, off the Norwegian coast. Both naturalists obtained an abundance of marine animals, and their results disproved the theory of Forbes that a zero of animal life was to be reached at a depth of a few hundred fathoms. In 1866 he visited Norway, and made a close study of the forms obtained by Sars, finding that many of these were new to science and of extraordinary interest, especially in their affinity to extinct species. Some time subsequent to this, when engaged in studying the development of *Antedon rosaceus* with Dr Carpenter, he strongly urged the latter to use his influence with the Royal Society for the purpose of obtaining a Government vessel, in which they might conduct scientific dredging.

In 1868 H.M.S. "Lightning," and in 1869 H.M.S. "Porcupine" were equipped by the Government, and were sent out under the scientific direction of Dr Carpenter, Mr Gwyn

Jeffreys, and Professor Wyville Thomson, for the purpose of obtaining a sample of the fauna of the deeper waters of the North Atlantic. The dredgings resulted in the discovery of many new animals, and important observations were made on submarine currents and temperature. Sir Wyville, who took a very active part in the work of these tentative expeditions, became their historian in his well-known "Depths of the Sea."

On the retirement of Professor Allman, he was elected Regius Professor of Natural History in the University of Edinburgh. He originated the practical teaching of zoology in connection with his class, which he raised to a very high place in the estimation of the students. For some years his course of lectures was more numerously attended than any other in the University.

During the first two years of his professoriate in Edinburgh, his time was largely occupied in working out the zoology of the expeditions of 1868-9. These results, and those of similar Swedish and American scientific voyages, led him strongly to desire and to urge that the Government should despatch an expedition, on so grand a scale, that the conditions of life in the greatest ocean depths might be examined. The Royal Society took the matter in hand, using its powerful influence with the Admiralty for the same object. This agitation at last resulted in the equipment of the famous "Challenger" expedition, and Wyville Thomson, to whom the credit of originating the expedition undoubtedly belongs, was appointed Director of the Civilian Scientific Staff.

The details of the voyage of the "Challenger," which were followed with constant interest not only by the scientific but also by the general public, are so much matters of common knowledge, that we need not here dwell on them. The vessel was absent from England three years and a half, traversing a course of 68,899 miles in the Atlantic and Pacific, visiting Australia, the Malay Archipelago, and penetrating as far south as the Antarctic ice-barrier. Soundings were taken and dredgings were carried on at 362 stations, the first of these being established on the 30th December 1872, the last on May 6, 1876.

On his return Sir Wyville was appointed Director of the "Challenger Deep-Sea Commission," formed for the purpose of working out the results of the "Challenger" dredgings and physical observations. His time was so fully occupied with this, and with his enormous University classes, that he could find comparatively little to spare for the original scientific investigation which he planned, and partly carried out, on the Crinoids and Hexactinellid Sponges of the expedition. In June 1879 a sudden failure of health obliged him to discontinue his University work, and as he never thoroughly recovered he resigned his professorship in October 1881, and the directorship of the "Challenger" Commission at Christmas of the same year. He died at Bonsyde on the 10th March 1882.

Sir Wyville will be best remembered in science as being the principal originator and administrator of the British deep-sea dredging expeditions. A complete list and estimate of his published writings will be given elsewhere, so we need here only notice his two volumes on the Challenger expedition—"The Voyage of the Challenger"—"The Atlantic," which were written during the cruise and published on its completion. His principal contributions to the Royal Society of London were the valuable papers "On the Embryogeny of Antedon rosaceus," "On Holtenia," and "On the Echinoidea of the 'Porcupine' Deep-sea Dredging Expeditions." We have already referred to the lucid narrative of the earlier voyages given in his "Depths of the Sea."

Sir Wyville was highly esteemed by his colleagues in the Senatus, and with his students was a very favourite professor. He had much sympathy for the young; those who showed the desire for learning or research were always sure of his help and encouragement.

Few men have owed so much to native gift and attribute. The personal charm for which he was proverbial, and which made him the delight of troops of friends, was the result of the union of many qualities not usually found associated. Of a noble form and of singularly handsome features, the impression he produced was that of one of commanding power and intellectuality. His suggestion was

man-compelling as another man's argument. Of exquisitely refined and delicate taste and feelings, yet genial, courtly, lavishly hospitable, always prone to look at the kindly and humorous aspect of things. Those who knew him best now feel that his loss has made in their lives a lasting void.

XXVII. *River-Terracing: Its Methods and their Results.* By Hugh Miller, A.R.S.M., F.G.S., of H.M. Geological Survey.

(Read 24th March 1883.)

CONTENTS.

Introduction.

Much of the work of modern geology consists in the filling-in of outlines. The day is almost past, in Britain at least, for happy generalisations from rapid surveys. The generalisations of the future are to be the work of men who have mastered with minute fidelity the alphabet and dictionary of the science. The every-day work of geologists is to be a modest elaboration of detail upon a ground-work of outline long ago drawn out by the master-hands of the past.

This paper is an essay towards the elaboration of an outline sketch produced by one of the firmest hands that have ever worked in geological landscape. The hand was that of Playfair, and it is fitting that his outline should here stand first.

"When the usual form of a river is considered," says Playfair, "the trunk divided into many branches which rise at a great distance from one another, and these again subdivided into an infinity of smaller ramifications, it becomes strongly impressed upon the mind that all these channels have been cut out by the waters themselves; that they have been slowly dug out by the washing and erosion of the land; and that it is by the repeated touches of the same instrument that this curious assemblage of lines has been engraved so deeply on the surface of the globe. The changes which have taken place in the courses of rivers are to be traced in many instances by successive platforms of flat alluvial land, rising

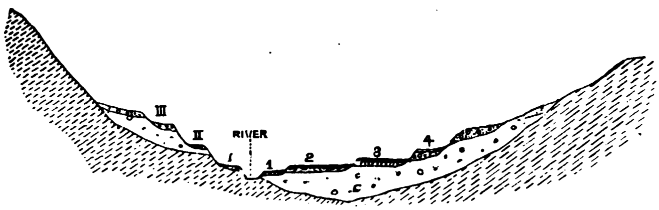


Fig. 1.

Ideal Section of a Terraced Valley.

1, 2, 3, 4, and I., II., III., Terraces of Gravel and Alluvium, excavated in boulder clay and rock. Highest terrace without alluvium.

one above another, and marking the different levels on which the river has run at different periods of time. . . . Each change which the river makes in its bed obliterates at least a part of the monuments of former changes; . . . only a part of the progression can leave any distinct memorial behind it." *

* Illustrations of the Huttonian Theory, Edinb. 1802, p. 102. "Such platforms, or *haughs*, as they are called in Scotland," adds Playfair, at another page of his classic work, "are always proofs of the waste and detritus produced by the river, and of the different levels at which it has run; but

SUBSEQUENT HISTORY AND LITERATURE OF THE SUBJECT.

The literature of the subject, after Playfair's time, if not voluminous, is at least extensive. In this country it chiefly consists of passing references in text-books and local memoirs. In America and in Norway, terrace-formations, existing upon a grander scale, have received more attention. The progress of opinion during the last eighty years has been slow enough. There has been the usual search after other causes to account for the same effects; but, now-a-days, alluvial terraces in valleys are almost everywhere recognised as the work of the rivers. Among many working geologists there exists an almost tacit understanding as to the methods by which river-terracing has been accomplished. But there is still not a little misapprehension abroad, and less, perhaps, has been added to Playfair's original outline than might have been expected.

I need only allude to the old cataclysmal views which stood in the way of the Huttonian theory,—waves of translation, for instance, and other suppositious floods,—sudden emergence of countries from the sea, whereby the waters were thrown violently off,—earthquake-formation of valleys and lakes, whose waters were drained from level to level by ruptures in the rock below. The fragile and uninjured land shells contained in the terrace-alluvia, proved them to be ordinary deposits; and it came to be better understood that geology and common sense, alike, cannot exist if rare or imaginary accidents are to be accepted as the explanations of what is universal, only because they might act swiftly.

Many of the early geologists were carried insensibly from the terraces of the old coast lines into those of the rivers in the interior. This transition was found by Darwin * in South America, and by Robert Chambers † in parts of Britain.

they sometimes lead us further, and make it certain that the great mass of gravel which form the successive terraces on each side of the river was deposited in the bottom of a lake" (p. 355). This statement, which may apply to pre-existing valley-deposits of any kind, has been kept in mind in drawing the diagram, Fig. 1.

* Geological Observations in South America, 1844.

† Ancient Sea Margins, 1846.

Both drew the inference that the terraces of the coasts and the rivers were due to the same cause. Darwin's terraces, on entering the mouths of the valleys, assumed the seaward slope of the rivers; he found them to be continuous with "terrace-like fringes" among the Cordilleras in the interior, at 7000 to 9000 feet above the sea-level. He accounts for the whole series by "the arrestment of river-borne detritus at successive levels" by the sea; in other words, by the formation in each valley of a sloping delta lengthened out by a process of gradual elevation, and passing into beach-lines around bays—the terrace-steps being sea-cliffs drawn gradually away from the power of the sea.* Robert Chambers gave a similar explanation of the few sloping terraces which he observed in Scotland, but he seldom noticed their slope, and includes the terraces generally as level sea-margins. This latter view has been abandoned. The terrace-gravels are not of marine origin; they contain shells of the land and fresh water, but not of the sea, and the alternation of conditions—fresh water and marine—so sharply marked in terrace-deposits towards the mouth of some valleys, *e.g.* the Somme, only serves to give point to the difference. His explanation of the sloped terraces has fared better. He supposed them to be the *wings*—as he phrased it—of successive deltas raised and intersected one after another as the land, stage by stage, arose from the sea. This view has been widely accepted. It differs from Darwin's only in assuming intermittent elevation.

With some modification it was this view that was taken by the uniformitarian school during the controversy respecting the palæolithic terrace-gravels of the Somme Valley and Southern England. "According," says Prestwich, "to any variability in the rate of elevation, to intervals of repose, or to deflections in the flow and velocity of the rivers, so there may exist intermediate terraces or levels, sudden variations in the slopes, and gravels lodged at various levels." †

* *Loc. cit.*, pp. 258, 291.

† Phil. Trans., 1864, vol. cliv., p. 298. It is right to remark that the phrase "deflections in the flow and velocity of the rivers" also covers the ground occupied by Hitchcock. See *postea*.

Prestwich was preceded in this view by Lyell, who held it as early as 1841, and seems to have held it unmodified to the last.* Lyell had early pointed out how streams cross and recross the general line of their descent, levelling out the plains that afterwards form the terraces.† About the time of the Somme controversy, Dana, in America, was working out the same views, and embodying them in the first edition of his Text-Book.‡ Whitaker,§ and Foster and Topley,‖ in England, and, more recently, Milne Home¶ in Scotland, and Hull** in Ireland, have also explained the terraces which they have described, by means of successive accelerations in excavating power produced by successive elevations of the land.†† Mr Milne Home in this manner

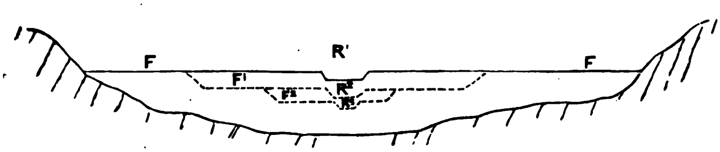


Fig. 2.

Section of a Valley, showing the Formation of River-Terraces during successive elevations of the land (Dana, Manual of Geology, 1863, p. 555).

R^1, R^2, R^3, successive River Channels ; F, F^1, F^2, successive Flood-Plains.

interprets the whole interior of the Tweed valley, holding that "as the sea fell from one level to another, so must also the rivers have fallen from one channel to another," even throughout their whole length.

In Playfair's original sketch it will be noticed that there is no allusion to the sea. Hutton and Playfair were well aware of the existence of raised beaches; their whole philosophy postulated elevation as placing the land within reach

* Students' Manual of Geology, 1871, p. 78.

† Principles of Geology, 1830.

‡ Text-Book of Geology, 1863.

§ Guide to the Geology of London and Neighbourhood.

‖ The Medway Gravels (Quart. Jour. Geol. Soc., vol. xxi. (1865), p. 443).

¶ Trans. Roy. Soc., Edinb., vol. xxvii. (1875), p. 513.

** Physical Geology and Geography of Ireland, 1878.

†† And so also Professor Bonney in respect of the Norwegian terraces (Geol. Mag., 1871, p. 239), and Greenwood (*Ibid.*, p. 239).

of denudation; but it by no means follows that Playfair, or, indeed, all who have just been cited, viewed river-terracing as impossible apart from successive elevations of the sea-board.

Hitchcock, in America, seems to have been among the first, after Playfair, to recognise that rivers, with sufficient power of flow, will make terraces even if left to themselves.* The interior terraces of the Connecticut, he says, are not best explained by successive elevations of the land.† In subsequent writings he distinguishes two classes of river terraces; —those cut from level to level as the ocean by stages retired, and those due to a natural tendency of rivers to terrace their banks. In his "Illustrations of Surface Geology," however, he complicates his earlier statement by an unfortunate "ideal section" representing each terrace as built up separately

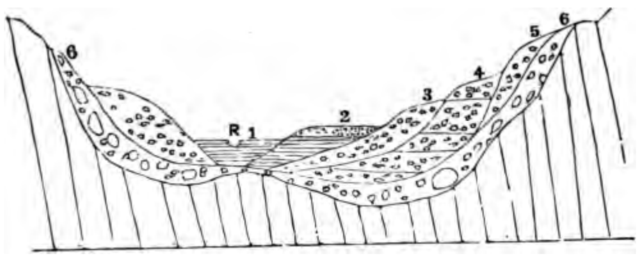


Fig. 3.

Ideal Section of a Terraced Valley (Hitchcock, Geol. of Vermont, 1861, vol. i., p. 96).

1, Alluvial Meadow, with R, river; 2 and 3, River Terraces of coarser materials; 4, "Moraine Terrace," or highest level-topped terrace, containing ice-dropped materials. This terrace has subsequently become irregular through the melting of ice; 5, probable Sea-Terrace or Beach; 6, Glacial Drift resting upon rock.

from the bottom of the valley.‡ There is much, however, that is of great value. The river terraces are distinguished both from lake terraces and maritime terraces. They slope with the valley. Their number and height are often different

* Geology of Massachusetts, 1833, p. 136. † *Ibid.*, Edition of 1841.

‡ Illustrations of Surface Geology, 1857. I have not seen this work, but the same views of river action and the same diagram are given by C. Hitchcock in "Geology of Vermont, 1861," pp. 94-190.

upon its opposite sides, though the eye may take them to correspond. They are arranged in basins, with solid rock narrowing the valley at the foot of each of these, and, on the Connecticut, between mouth and source, he distinguishes of these basins no less than twenty-two. He accepts Robert Chambers's views respecting intersected deltas for those that are of equal height on both banks; but the greater number are due to the river alone. Its method of action is not made very clear, but he at least recognises that rivers, as a result of their tortuosity, cut in on one side and deposit on the other; and, although totally at variance with his ideal section of a terraced valley, it appears to be the same method as that which the following pages may perhaps illustrate. Hitchcock distinguished the terraces of the Connecticut into four groups:

The Lateral, or ordinary terrace;
The Delta terrace, being the intersected deltas at the mouths of tributary streams;
The Gorge terrace, occurring either above or below gorges, and stated to be "intermediate between the lateral and delta terraces, graduating into both;" and
The Glacis terrace, a doubtful group, having a slope away from the river, as well as the usual bank towards it.

Such was the importance which Hitchcock assigned to the American terraces, that he proposed to divide the Post-pliocene into three periods: a Drift period, attended by a submergence, which he supposed to amount to 5000 feet; a Beach period, marking the country's emergence; and a Terrace period, following thereupon.*

In this country Sir A. C. Ramsay,† Dr Arch. Geikie,‡ and

* It has since been determined that the submergence was by no means so great, amounting only to 470 feet at Montreal, and diminishing to 10 to 25 feet on the southern shores of New England (Dana's "Manual," 1881).

† Physical Geology and Geography of Great Britain (Fifth Edition, p. 530).

‡ Manual of Geology (Jukes and Geikie), 1869; and Text-Book of Geology, 1882, p. 383.

Professor James Geikie * have recognised rivers as seeking down from level to level without necessary aid from changes at the sea-coast. Terrace-making is connected, by Dr Arch. Geikie, with the winding and looping of the river, prolonged erosion carrying it to levels from which it can no longer reach its former flood-plains, whereupon it works into new ones. Methods of river-terracing receive some admirable illustration from C. Barrington Brown's paper "On the Ancient River Deposits of the Amazon" (Quart. Jour. Geol. Soc., 1874, p. 333).

Hitchcock's view of the terraces of the Connecticut has since been more clearly stated, without his unfortunate diagram, by Upham,† who confirms the non-correspondence of the lower terraces on the opposite sides of the valley. He accounts for the highest terraces, which he finds to stand more strictly *vis-à-vis*, by the great floods of the Champlain or Glacier-melting period. In British Columbia G. A. Dawson finds similar facts to be accounted for. Automatic river-action explains the lower terraces; but he believes flooding by submergence necessary to explain the uppermost level.‡ An admirable reference to the subject of river-terracing, evincing the widest knowledge, is also made in G. K. Gilbert's "Geology of the Henry Mountains," a section of which contains a truly scientific treatise upon denudation in general.

The Huttonian view of the planing-out of river terraces at successive levels has found several rivals, which can scarcely yet be considered out of the field. Mr Gilbert, in the work just cited, points out that it is a mistake to suppose that the higher terraces were made by a great volume of water when the valley was as open as now. Mr A. Tylor, however, has maintained that the flint-bearing terraces of the

* Prehistoric Europe, 1881, p. 181. In the diagrammatic sections given by the three authors last named, the river terraces are represented in opposite pairs.

† W. Upham. The northern part of the Connecticut Valley in the Champlain and Terrace periods (Amer. Journ. of Science, 3d series, vol. xiv., p. 453, 1877).

‡ Superficial Geology of British Columbia (Quart. Jour. Geol. Soc., xxxiv., p. 274).

Somme Valley are ancient flood-margins of the river while flowing in its present channel. He holds that in England the valleys are adapted to hold rivers many times as great as now, and supposes a "rain period," during which rivers, such as the Aire in Yorkshire, had 125 times their present volume.*

The same view has since been taken of terraces in the Earn and Teith by the Rev. Thomas Brown.† Dana, too, discarding his earlier views of the Connecticut terraces, now traces them almost wholly to the effects of gigantic floods caused by the melting glaciers of the great Ice Age in America. The terraces mark stages in the rising or retreating deluge, which must, if so, have risen from 200 to 250 feet above modern low water. Dana is well aware, however, that floods of so great a magnitude would sweep away all but the coarsest possible *débris;* and he calls in the unequal elevation of the continent since glacial times to lessen the gradient.‡ In this country there is no river on which any inequality of elevation of which the raised beaches give evidence could have any such effect; and the structure of the river-terraces is incompatible with this almost cataclysmal explanation.

Smaller climatic changes are less open to objection. Whitney § believes that "gradual and uninterrupted action of eroding forces" is unfavourable to the formation of river terraces, and supposes a succession of "periods of drainage alternating with periods of repose." Drew, in the Himalayan Valleys, ‖ seems to connect the river terraces with variations in the supply of *débris*, disengaged by glaciers among the mountains.

In Norway, Professor Kjerulf, like Hitchcock, has recognised two classes of terraces: those in "closed situations," or in basins hemmed in at the lower end by barriers of moraine or rock; and those with an "open situation," where

* On Quaternary Gravels (Quart. Jour. Geol. Soc., vol. xxv., p. 57).

† Trans. Roy. Soc., Edinb., vol. xxvi., 1870.

‡ See footnote, p. 269.

§ J. D. Whitney, Geol. of Wisconsin, vol. i., p. 108.

‖ Drew, Alluvial Deposits of the Upper Indus Basin (Quart. Jour. Geol. Soc., vol. xxix., p. 441).

the valley expands without interruption towards the sea. The former he views as beaches of lakes, which burst their barriers from time to time; the latter, existing only below his "marine limit" of about 600 feet, beyond which the

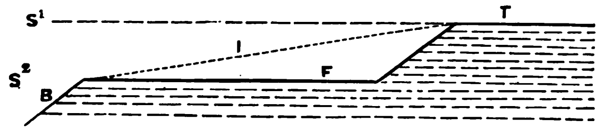


Fig. 4.

Terraces—Norway. (Kjerulf, Om Skuringsmærker, etc., p. 51.)

F, Flat, levelled-out by river near S^2, the sea; B, Submerged Bank in which these flats may terminate; T, Raised Terrace, due to the formation of a similar Flat and Bank at a former sea-level, S^1; S^2, S^1, sudden step of upheaval necessary to its preservation; I, shows Terrace-making to be prevented by gradual elevation—F being converted into an incline, and B kept at the foreshore.

plentiful remains of marine *exuviæ* abruptly cease, consist of steps marking the retirement of the sea, to steep submerged margins of which the terrace-fronts correspond.*

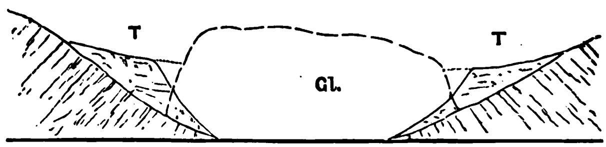


Fig. 5.

Section of Valley, showing probable lodgment of gravelly *débris* between a glacier and the side of a valley, afterwards falling into terraces.

Gl, Glacier in retreat; T, T, Terraces (Jamieson, Quart. Jour. Geol. Soc., 1874, p. 333).

Mr Jamieson, of Ellon, has suggested yet another mode of terrace-formation, and appears willing to apply it not only to high-lying terraces in Highland glens, but to such terraces

* Om Skuringsmaerker, Glacial Formationen, og Terrasser, 1871, p. 51. Kjerulf's views are widely accepted in Norway (Reusch, "Traek af Havets Virkninger paa Norges Vest Kyst"—Nyt. Mag. for Videnskaberne, 1876). Petersen, however, finds evidence that the sea did not always retire in steps ("Terrasser," etc., Tromso, 1880); and Gumælius proves that terraces may be of unlike heights on the opposite sides of dales. The latter believes that the Norse terraces answer to the Swedish asar (Kames), and were formed under the sea (Gumælius, "Rullstengrus, Terrasser, etc."—Geologiska Föreningens i Stockholm Förhandlingar, 1880, p. 184).

as those of the Earn and Teith.* I am informed by my colleague, Mr J. Grant Wilson, that of the former it is sometimes an effective explanation; but to the latter it can apply only in the absence of any other more suitable.

Fig. 5 will explain Mr Jamieson's supposition of morainic gravel washed alongside a melting glacier, and left to fall into terrace shape when the support of the ice is withdrawn.

Summary of Opinions on the Origin of Valley Terraces, chiefly known as River Terraces.

That they are ancient sea margins.

That they are portions of ancient river-flats, deserted from level to level as the land arose stage by stage.

That they are portions of ancient river-flats, deserted from level to level in consequence of periodic increase of erosion due to cycles of climate.

That they are indented margins of ancient and monstrous floods, rising from about the level of our present rivers.

That some of them are the margins of ancient lakes, tapped in stages.

That some of them represent fluvio-marine banks, once fringing estuaries near river-mouths and suddenly upheaved.

That some of them are due to morainic *débris*, banked-up against the sides of melting glaciers.

That they were submarinely formed, and answer to Kames or åsar.

That they are chiefly due to the unaided operations of rivers worming themselves from level to level in the ordinary course of valley-excavation, liable to impulses towards increased erosion due to various causes.

* On the Last Stage of the Glacial Period in Great Britain (Quart. Jour. Geol. Soc., 1874, p. 333).

River-Terracing—Its Methods.

In the excavation of valleys, streams do not generally confine themselves to the narrow limits of a channel along the middle. They extend their operations over some breadth of ground, upon which they wind and shift, erode and deposit; keeping open for their own use only a narrow channel, and flooring the rest of the bottom of the valley with alluvial deposits. The methods by which flat-bottomed valleys result from the movements of a single winding thread of flowing water within them, are also the methods by which the level alluvium-strewn surfaces are ranged into tiers of planes separated by those successive steps or embankments that convert them into terraces.

The powers of running water to waste, excavate, and transport, need no demonstration here. The works of Hutton and Playfair, De la Beche, Lyell, Ramsay, Jukes, Arch. Geikie, and many others whose names belong to the history of geology, have rendered them part of the simple alphabet of the science. We say nothing, therefore, of the importance of rivers as graving tools in earth-sculpture; it is only necessary to refer to some of the turns and touches, as it were, of the point of the instrument. The section of river terraces consists (Fig. 1) of surface planes, gravels and alluvia spread thereon, and edges or terrace-fronts facing the river. We limit ourselves to some account of the methods by which these several parts are formed and combined.

Formation of River-Curves—Deflection-Pools.

It was pointed out by De la Beche in his "Geological Observer," and is one of the most familiar of facts, that streams, winding as they go, tend to scoop at the elbows of the curves. A straight course does not suit the conditions of a mobile fluid passing over a variable bed. Some inequality in the channel or weakness in the bank is sure to direct the force of the stream against one side, and it then begins to cut side-

ways, eating out a curve. The shape of the bottom changes. The apex of the V or U, which its cross-section may have originally resembled, is forced to one side. The water, heaped up and recoiling, bears against the obstructing bank and bottom; the one is scarped into a cliff, and the other is scooped into a pool. After having rounded the curve thus made, the stream shallows and passes on. One curve, however, propagates another. After being deflected from one bank the stream is projected against the other; and thus results that succession of curves and pools with which every one who has had to do with rivers, whether as fisherman, or bargeman, or engineer, is so familiar. The pools so formed may be termed *deflection-pools.**

Travelling of River-Curves and Deflection-Pools.

The bends in a stream acting as partial dams in its course,† and the water in being thrust back and turned aside, gnawing ceaselessly at the bank which deflects it, deflection-pools and the scars or cliffs that border them, are never perfectly stationary. They are all being worked more or less in the direction of stream-flow; many of them tend, upon the whole, to travel down the valley. When the stream works among soft materials these movements can be measured; in floods they may render themselves alarmingly self-evident. Tylor cites a case in which a deflecting bank of the Ganges travelled 150 feet laterally in one flood. During the famous Morayshire floods of 1829 this figure must have been frequently approached. There is an interesting paper in the *Proceedings* of this Society showing, by a chart, the effects of a violent

* Dr James Geikie has applied the term deflection-*basin* to certain lakes,—on Ramsay's theory, glacier-scooped,—lying adjacent to high grounds against which the ice-streams of the Glacial Period abutted. It is well that phenomena so analogous should have analogous names. In British rivers deflection-pools are pools only. In such gigantic rivers as the Amazon and Mississippi they are lake-like; and when isolated by those shifts of channel known as "cut-offs" form lakes often 10 or 12 miles in length. The writer has elsewhere had occasion to point out the importance of deflection-pools, as carrying out the analogy between rivers and glaciers in view of the supposed lake-forming power of the latter (Geol. Mag., 1877).

† Humphreys and Abbot, Physics and Hydraulics of the Mississippi, 1876, p. 333.

flood of less than an hour's duration upon the Dollar Burn in 1877.* A portion of this map, illustrating the unfailing tendency of a flowing stream to throw itself from side to side as it goes, and its method of carrying its bends along with it, is here transferred (Fig. 6).

Fig. 6.

Part of a Stream at Dollar as affected by Flood. Thick black lines indicate changes in the banks (after And. Taylor, Proc. Roy. Phys. Soc., Edinb., vol. iv., p. 220).

This stream was described by another writer as—"Sweeping out to right and left in great curves, eating away the ground, which was largely composed of big boulders, in a fearfully rapid manner," so that the onlookers had to pace backwards "with regulated steps." †

The travelling of the curves in a river gives to it some degree of resemblance to a line laid out upon the floor and shaken into lateral undulations by a movement of the hand. But in the river this movement is necessarily very irregular. In order that curves should travel in a regulated succession it would be necessary to arrange a balance between the force and the resistance which it is obviously impossible to maintain. The banks are attacked at constantly varying angles; the materials encountered are seldom for any distance uniform. Nor do these considerations apply less to the different parts of the same curve than to different ones. Our northern valleys, of date older than the glacial period, usually present, first, an inner flooring of

* Proc. Roy. Phys. Soc., Edinb., vol. iv., p. 220.

† Trans. Geol. Soc., Edinb., vol. iii., p. 170.

alluvium; secondly, a casing of boulder clay; and thirdly, the outer frame-work of rock. It is clearly impossible to maintain a balance of force and resistance in any curve which in its oblique course shall successively traverse them all.* Hence arises that distortion of open curves into closing loops and horse-shoe bends which renders the courses of some

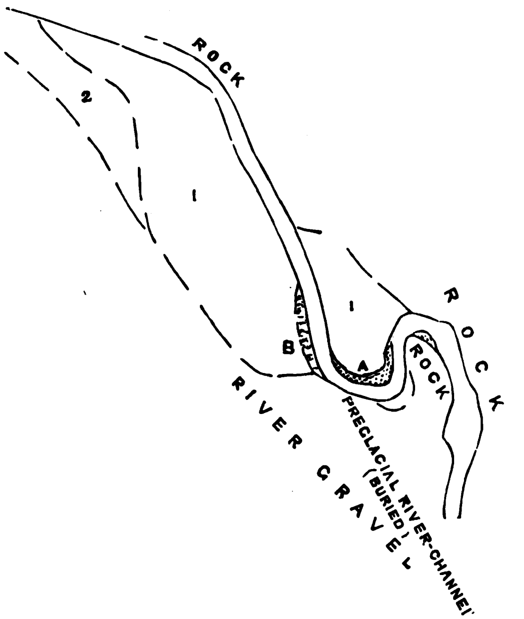


Fig. 7.

Part of the River North Tyne (near Chipchase), illustrating the relation of the river to its preglacial course.

1, 2, Terraces; A, Gravel banks; B, Recent addition to 1.

streams so tortuous, and which often goes on until the two extremities of the horse-shoe come together, and the water breaks through. Hence, too, mainly arises those sudden shiftings of channel which occur during floods.†

Some of these facts will be illustrated by Fig. 7.

* It will be noticed, however, as conducing to this balance, that force and resistance in such cases are both least in the alluvium of the middle, and greatest in the rock at the sides.

† The heightening of the plane of water above each curve (which in floods has sometimes been observed to be, or to appear, as much as 10 or 12 feet) makes flood-overflow take place first where the water is thus checked. At first

Towards the right the river-course is fixed in rock, and the lower loop may be regarded as relatively *persistent.* On the left the river flows upon softer glacial deposits with some covering of alluvium, and the upper part of the loop (with the slight bend above it) may be regarded as relatively *shifting.* The shifting curve is endeavouring to worm itself past the persistent one, along the line of a buried pre-glacial channel occupied by till. The limb of the stream above the gorge has probably worked within its trapezoidal strip of alluvium somewhat like the limb of a piston. At present this movement is taking the form of a slow progress to right on the part of a gentle curve above the double loop, which, exhausting itself at the gorge, may temporarily straighten the upper half of it, until such time as the limb of the piston may come down again along the bank upon the left. We have seen such movements as this latter, very beautifully recorded in the age of the vegetation clothing the bank left by the advancing bend. Bushes and saplings grew nearest the fresh scar beside the deflection-pool; these gradually rose into trees of a larger growth further up valley, and massed into a bank of hanging wood.*

Planation.

These methods of river-action result in an intermittent planing-out of the strata along the line of the valley. Each river-curve, forced horizontally like a curved knife with the blade laid flat, may leave as it travels, not only a plane over

it is simply a diverting of the surface layer of water, but this latter may channel a course which shall divert the under current also and supersede the roundabout course. Some apparent shiftings, of course, are due only to the occupation by the water of secondary channels, which will be afterwards referred to.

* When, by these piston-like movements, the shifting bends shall have succeeded in cutting out the persistent one by breaching the lower neck of the double loop, a rocky knoll will of course lie in the valley, as in the case of the famous hills of Dunipace. An interesting case of loop-digging and its results is supplied by the river Irthing. This river forms, for 14 miles, a winding north-and-south boundary between Northumberland and Cumberland. It then bends west at Gilsland. At this point, nearly on the watershed of England, it had almost its choice of two valleys. It seems first to have chosen the eastern one, and to have turned sharply off towards the South Tyne and North Sea. The arrangement of its terraces now seems to indicate that it

which it has passed, but a bank along the base of which it has been drawn. The running water in its circuits may be likened to a scythe in its traverses along the edge of a field; there is a breadth of shorn stubble and a wall of standing corn. Vertical strata in a stream-bed, as all observers know, lie with their ends shaven off, like the strata that enter into a plane of marine denudation on the sea-shore. If the banks bordering the stream be of rock, and not too high, it may be found that the planing process has been pursued before at a higher level, and that there exists an upper plane of river-denudation with the truncated ends of its floor overspread with alluvium (Fig. 8).

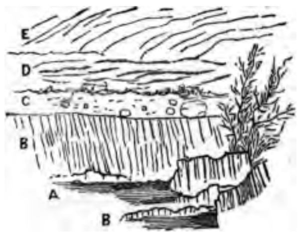


Fig. 8.

Planation—Tarret Burn, North Tyne.

A, Stream; B, Shales and Sandstones planed off at top; C, Sand and Gravel of—D, Alluvial Flat; E, Bank.

Still higher on the valley sides there may lie other platforms, similarly planed and overspread.

This process of cutting and levelling has been termed *planation.**

Relation between the Travelling of River-Curves and Formation of Gravel.

The methods by which surfaces of planation become

gradually doubled into a deep loop at the turn, the elbow of which was pushed further and further west until it at length burst over into a hollow leading into the Eden. Since then it has deepened 40 feet below the level of its old eastward valley, which remains with its empty flat and a selvage of higher terrace to tell the tale. My friend, Mr David Burns, C.E., first noticed this old valley. He supposed it to have been choked with ice when the Irthing was first forced to quit it. But the age of "ice-jams" seems to have been past ere the occurrence took place, judging from what I have seen of the gravels, and all the facts are well accounted for as above described.

* W. K. Gilbert, Geology of the Henry Mountains.

gravel-covered bear a direct relation to the travelling of the stream curves. Streams themselves occupying only a narrow waterway, all parts of their courses not kept open by the *scour* of the current are silted up with deposits of the stones, sand, and mud, which the stream has in train. Thus it comes about that the movements of curves are exactly kept pace with by the growth of alluvial deposits. The concavities of the river-bends are scooped out by erosion; the convexities that fit into them on the opposite side are thrust forward by deposition; and the windings of streams will generally exhibit on any one side alternate deflection-pools and gravel banks (Figs. 7 and 13).*

Fig. 9.

Sketch Section across a stream-curve, showing the formation of River Gravel by accretion.

Gra., Sd., B.Cl. = Gravel, Sand, and Boulder Clay.

In the transverse section of a deflection-pool we find that it usually shallows out from the deepest or deflecting side. At the base of the scar we can often see something of the raw material, whether rock or boulder clay, on which the river is at work. The stones in the stream-bed on that side —some of them freshly detached, others dropped from the grasp of the last flood when it began to slacken, and could drag them down stream no longer—are few and large, and, lying in the thread of the stream, are bearing the full force of the current. Crossing the stream from the deflecting bank, the bottom shelves up, the water loses its motion, the average size of stone underfoot becomes smaller and smaller, and the gravel may pass into shingle, pebbles, and pebblets, by a gradation evidently due to mechanical assortment connected

* In these figures the position of several gravel-banks is marked by stippling. The position of the deflection-pools may be inferred.

with the decreasing force of the water.* The gravel-bank, in fact, is growing by a process of accretion; coarser materials (with finer entangled among them) are added to its lower parts nearest the thread of the current; finer materials fall from the slackened grasp of the water further away from it; and the first tufts of grass, and first lodgment of sand, near the edge of the alluvial meadow above, may appear together, —the sand helping the grass to grow, and the grass entangling more sand. An instance may be cited from the Vale of the Coquet (Northumberland). While an alluvial curve of that river has been slowly pushing through 80 yards in 18 years (as determined by the position of some boundary-stones, and the age of the Ordnance map), a growth of gravel has kept pace with it from the further side; what was water before is gravel now, and what before was gravel is a flat of scanty pasture, receiving earthy top-dressings from floods, and harbouring, doubtless, an increasing colony of soil-forming worms.

According to the method just described, the formation of at least the gravelly parts of river alluvia is not a horizontal deposition of layers, but an accretion upon a slope, the finer gravel covering the coarser by a kind of overlap. The deposits of sand and loam that generally (sand first, loam above) succeed, lie in layers that fringe out and overlap, according to the height of the floods that formed them.

All this † is not without its bearing upon inductive

* This assortment of materials stranded on the way down stream will be all the better understood from a glance at the following table, showing the transporting power of water in motion at different rates :—

	Inches per second.		Miles per hour.	
Moving at	3	=	0·170	water will just begin to work on fine clay.
,,	6	=	0·340	,, will lift fine sand.
,,	8	=	0·4545	,, will lift sand as coarse as linseed.
,,	12	=	0·6819	,, will sweep along fine gravel.
,,	24	=	1·3638	,, will roll along rounded pebbles 1 inch in diameter.
,,	36	=	2·045	,, will sweep along slippery angular stones of the size of an egg.

D. Stevenson, Canal and River Engineering, p. 315.

† Although so simple as almost to require an apology for treating of them, the processes above described are not universally understood. The author of

geology. Since each flood tends to deposit stones, etc., in graduated sizes upon the *accreting sides* of stream-channels, it follows that if the flood-force of water be habitually great, the basement stones of the gravel beds formed by it will be proportionally large (Fig. 10), the gradation from these up

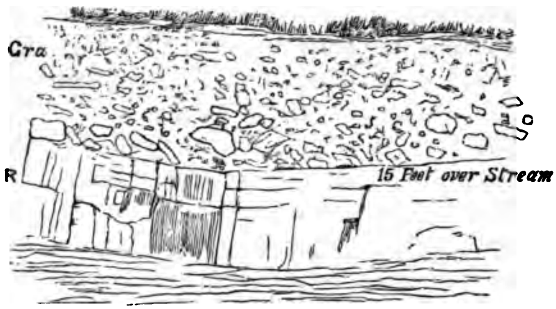


Fig. 10.
Section of River Gravel (Whickhope Burn, North Tyne).
Gra., Gravel, coarse in lower part ; R, rock, quarried.
NOTE.—This gravel-bed may be viewed as sub-torrential.

into alluvium proportionally extended, and the gravel-bed thick in consequence. The average thickness of gravel is determined by the average height of flood. When, therefore, we seek to know something of the bodies and force of water that deposited ancient river-gravels, we may expect to find it registered—(1.) in the average thickness of gravel, and (2.) in the size of the blocks deposited towards its base.* Floods of variable range will register the fact in a greater interweaving of coarse deposits with finer, and in more contemporaneous erosion; and any floods of extraordinary and

a series of articles now current in the *Geological Magazine* declares that "the two kinds of work "—denudation and deposit—are "absolutely antagonistic," in the sense that a stream "cannot at the same time act as a scouring agent, and as a depositing one" (*Geol. Mag.*, 1882, p. 442). The "Evidences of a Great Post-Glacial Flood," it would seem, are a little disconnected from much study of the effects of smaller ones.

* The largest blocks of all, of course, are those which the river has never been able to shift, but has only let down time after time as the valley deepened. These need have no reference to the force of the stream. The arrangement of recent torrential deposits can best be studied now-a-days, in this country, in the steep head waters of rivers.

gigantic potency will leave their deposits—not within the shelter of comparatively small bends and loops such as constitute the windings of modern rivers, but at larger curves—possibly the very largest in the whole course of the valley.

TERRACE-FORMATION.

The methods by which river-terracing is accomplished having now been sufficiently examined, we proceed to look into the prosecution of these methods, and the terraces in which they result. So far as possible we adopt Professor Edward Hitchcock's classification.

Lateral Terraces: 1. *Amphitheatre Terraces at Persistent Bends. Glacis Terraces.*

As we have seen, there are in every stream numbers of what may relatively be regarded as *persistent* bends, associated with others which may be viewed as comparatively *shifting* ones. Of the persistent bend we have the best example when a stream sweeps round the circumference of a deep curve, bounded on its convex side by a high bank of rock or boulder-clay, amphitheatre-like in aspect, and not least so in that the opposite or alluvial side is often benched with terraces rising in succession from the water's edge. These persistent bends, it need hardly be said, are working into the bank in the direction in which they belly.

While the stream is extending the curve at its circumference, a formation of gravel and alluvium keeps pace, as has been described, at its inner or sheltered side. In numberless cases that side seems to have enlarged by crescent-shaped additions. Accretion is not uniform. A gravel bank is sometimes piled up in a single flood around the margin of the curve, and, thinning at the ends, is crescentic in form. In cases where the stream-curve is deep and lobe-shaped, this process may be likened to a sort of *toe-capping.* The line of weakness between the capping and the body of the foot is liable to be used in floods as a secondary channel, the cap being then turned temporarily into an island. The more eligible lines of weakness may be retained in use for a con-

siderable time. Meanwhile accretion goes on—sometimes slow and even, sometimes by the addition of cap to cap. *Discarded* secondary channels remain as grassy furrows on the enlarging haugh; the *selected* one is kept open. There is less alluvial deposit in it so long as the deposit is liable to be swept out in flood-time.

The water that occasionally flows through this selected secondary channel is not entirely inactive. In most cases which the writer has examined, it is thrown, in splitting off from the main channel, against the opposite, *i.e.*, the inner or alluvial bank, of the secondary one. In this and other ways small reversed shifting bends are set up, and work their way along that side. The fresh alluvium, with its cover of turf, is ripe for undermining, and readily forms a scar; and thus, flood after flood, the furrow is etched out into a step or little terrace. The further it is worked in towards the body or *instep* of the foot, the higher and more terrace-like it becomes; and when the main channel, with its enlarging circuit, has progressed to a greater distance and lower level, with new gravel-accretions and other secondary channels, it is left high and dry. Many abortive terraces—represented by crescentic furrows—may be formed for every one that ultimately remains and is truly terrace-like; but as time goes on the larger of them are selected for preservation, and the lesser are obliterated; and the sloped side of the amphitheatre becomes *benched.* Contrary to the fashion of amphitheatre benches, however, the convexity of these imperfect crescents tends to face the hollow of the opposite bank.

For this well-marked variety of river terrace, which was not separately indicated by Hitchcock, we venture to use the name Amphitheatre Terrace.

The larger number of river terraces in this country are of this kind. Of those that have been mapped by the writer in the course of his work in the Geological Survey, 70 per cent. occupy positions in which they may be amphitheatre terraces, being placed, that is, on the sheltered side of more or less pronounced bends of streams. The absolute number of them actually thus produced is probably less.

Of this kind are the lower of the terraces lying within

loops of the Tweed below Old Melrose, shown in Sheet 25 of the "Geological Survey of Scotland," and here transferred (Fig. 11).

Each of the loops resembles a quarry, which the quarrymen are engaged in extending into the hill-side, deepening it—so far as they can without accumulating drainage—as they go. But some of the workmen now and then turn back from the quarry-face and work at the sloping floor, and convert it from an inclined plane into a series of steps.

This illustration will perhaps help to make it more evident:

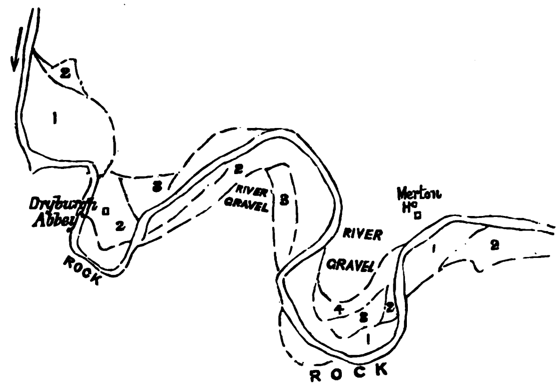


Fig. 11.

River Loops on the Tweed below Melrose, showing their effects in the production of Terraces (1, 2, 3, 4. etc.). (From Sh. 25, Geological Survey Map.)

Scale—1 inch to a mile.

(1.) that the superficial extent of the terraces bears some rough proportion to the size of the loop; (2.) that the accreting bank with its incipient terraces is commonly lower than the side answering to the quarry-face; * and (3.) that the terraces, if truly belonging to this variety (a fact which is often difficult to establish), are formed independently within each stream-loop, and in no two need be of the same height. Coincidences do necessarily occur: impulses there

* The nicety with which this rule is sometimes carried out is illustrated by the measurements given in Fig. 16, although the terraces there shown can hardly be called amphitheatre terraces.

also may be, common to different parts of the stream, such as excessive floods, cycles of climate, changes in the bed of the stream, movements of the surface of the country, etc.; but in the experience of the writer the great majority of river terraces are not of equal height on opposite banks. The following list of measurements, made chiefly in terraces of this kind throughout six miles' length of the river North Tyne, will indicate that coincidence in height is at least exceptional in our northern valleys. The small figures attached to the larger ones denote several recurrences of the same height at different points.

Measurements of Terraces between Chollerford and Houxty Burnmouth, on the river North Tyne.

HEIGHTS IN FEET.

5,	6,	8^2,	9^2,	11^2,	12^4,	13^5
15^2,	16,	17^2,	18,	19,	20^2,	21
22,	24,	25,	27,	38,	39,	58

The flood-level (12 or 13 feet), to which the river builds its banks where it remains long stationary, is naturally represented better than any other. It will be noticed that beyond this there is no disposition in these figures to fall into groups.

Nothing can better illustrate the unequal and variable height attained by certain lateral terraces—including the variety now specially referred to—than the fact that the same terrace will sometimes be found to vary as much in height as if it were several different ones. The surface, in such cases, has been levelled at different times without the preservation of a terrace high or distinct enough to attract regard. Many crescent-shaped or lobe-shaped *haughs* in upland streams are scored with incipient terraces, and yet cannot be mapped as other than a single terrace. The number of amphitheatre terraces that are not more or less *composite* cannot be great.

A variety of the amphitheatre terrace is often found to assume the characters of Hitchcock's *glacis terrace,* its plane having more or less of a tilt away from the stream (Fig. 12). The secondary channels above described often temporarily

divert large bodies, or even the whole, of the main stream. Shifting curves may then play for a time along the edge of the future terrace with much of the force exerted by more persistent ones, cutting their way laterally in the oblique plane

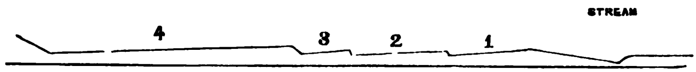


Fig 12.
"Glacis Terraces" (Whickhope Burn, North Tyne).
Scale—both horizontal and vertical—1 inch = 60 yards.

which planation accompanied by deepening must necessarily follow. When left thus, glacis-terraces result. The angle of the glacis slopes shown in the transverse section (Fig. 12) does not exceed $1\frac{1}{2}$ degree; it sometimes attains at least as much as 5.

Lateral Terraces: 2. *Junction Terraces.*

At the junction of streams there is a manifest tendency in both currents to keep clear of what lies in the angle between them. A spit of gravel is apt to accumulate (by accretion of materials stranded on their way down-stream) at the point,

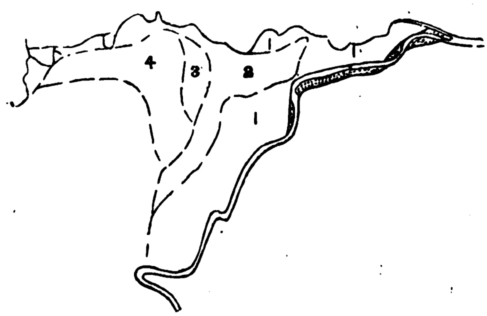


Fig. 13.
Terraces preserved at a junction of streams (Chirdon Burn, North Tyne).
Scale—3 inches = 1 mile.

and by continual growth may in time form a triangular flat. Thus are constructed planes, which periodical destruction at successive levels may convert into terraces; and the means of periodical destruction are close enough at hand. The

position of the point of stream-junction is obviously a vacillating one. These triangular haughs, in fact, may be likened to flat-pointed boards, from the two edges of which a boy is occupied in taking out large scoops with his knife, now on one side, and now on the other. It will be found that one or other of the two streams is in process of sweeping-in with a curve, which must, as it advances, cut away a section of the triangular flat, giving the stream a fresh opportunity to form a new *haugh*, at a lower level, and in front of the first. By these means, as the valley deepens, a whole succession of terraces, more or less prow-like in profile, may stand above one another (Fig. 13). The more shifting of the two streams tends to drive the point of the prow further towards the other. Like amphitheatre terraces, these junction terraces are formed independently within their recess, and have different heights compared with the terraces at other parts of the stream.

Lateral Terraces: 3. *Indeterminate Varieties. The Lateral Terrace proper.*

It would be well that the terms amphitheatre terrace and junction terrace were restricted to terraces having so definite a relation to the play of shifting bends within persistent ones, or at stream-junctions, that they may be identified as having been, so to speak, born and cradled where they now lie. Considerable numbers of terraces, originally belonging to the amphitheatre variety, may of course have been formed within bends which, though at the time relatively persistent, are now lost. The changes that have been wrought in many valleys, since planation first produced terraces in them, have often necessarily disconnected terraces from their original environment. There is also an ill-defined group, exemplified by the lower terraces in Fig. 16, of which all that can be said in the way of definition or nomenclature is, that they are lateral terraces, having no very determinable relation to persistent bends, formed independently on the opposite sides of streams, and not usually exactly *vis-à-vis*. The typical member of this group is a terrace due to lengthened traverses of the river-bank by

curves that have made good their way for considerable distances; but although so easy to define theoretically, it is difficult to identify. It is the lateral terrace *par excellence*, and may be likened to the planation of a cutting-machine passing along the side of a field, and taking out strips of it. Its formation may be illustrated by Fig. 14. A is a river-

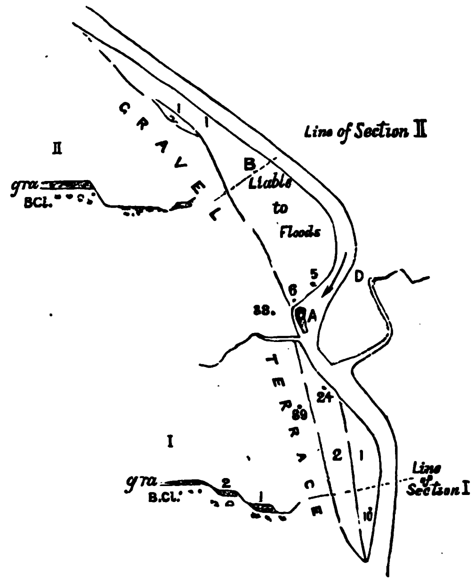


Fig. 14.

Part of the North Tyne, near Wark, illustrating the growth and destruction of River Terraces.

A, Curve, shifting down stream; B, Haugh forming behind it; C, Sand-bank (1865) now (1883) being added to B; D, Tributary streamlet now broken in upon at that point; 1, 2, Terraces below A; 1′, Lower Terrace replacing them, and 2′, probable selvage of 2. The other figures denote typical points of elevation above river in feet. I, II, Sketch sections; Gra., Gravel; B.Cl., Boulder Clay.

Horizontal Scale—3 inches = 1 mile.

curve hitherto in slow progress down stream; 1 and 2 are step-like terraces on the bank further down the river, which it destroys as it advances. The large flat B is a haugh at a lower level (as will be observed from the measurements given

in the Figure), which appears to have been substituted for these two by the same process of growth exemplified in the bank C, which, twenty years ago, was a sand-bank, but is now covered by coarse grass and osiers. The terrace-front bordering the haugh B on its landward side is equal in height to the destroyed terraces combined, a vestige of one of which may be that preserved on its flank at D.*

Fan Terraces, or Lateral Delta Terraces.

River terraces in valleys are usually found to slope up towards the mouths of tributary streams, and in these positions, having some distinct characters of their own, they have been termed by Hitchcock *delta terraces.* It would be well, however, that the term delta terrace should be restricted to terraces formed by intersected deltas at or near river mouths. In this paper *lateral* delta terraces will be referred to as fan terraces.

All deltas are due to a building-up of alluvial *débris* around the mouth of a valley or ravine. It needs scarcely to be said that they are not necessarily or mainly submarine or sub-aqueous. Shot *débris* spreads in the shedding, whether under water or above it. The fan-shaped talus round the mouth of a rocky notch; the alluvial cones that are shed around the mouths of tributaries on valley sides; and great river-deltas spread over miles of seaward-flattening valleys like the Nile or Ganges—are all primarily due to the same principle. A point has been reached at which the *débris* can be carried no further; it is accordingly laid down at some point in front of the point of exit, or "*gate*," as the Americans term it; and if the "gate" open at right angles to the bank, the materials extruded arrange themselves in a semicircular fan or delta. The formation of these deltas has been described

* All the evidence which the writer has obtained goes to show that the above is the correct reading of the terraces represented in the Figure; at the same time it is used more as an illustration than taken as a fact. It will be observed that the curve A bears somewhat the same relation to a larger curve of the river that a shifting curve bears to a persistent one in the formation of the amphitheatre terrace. This does not seem, however, to be an essential feature of this case, seeing that it might produce similar results without it.

by an American geologist * in language so scientifically graphic that we make no apology for quoting it.

"When the stream is progressively building up its bed outside of the gate, it is obvious that it cannot long occupy one position, for if it persisted in running for a very long time in one place, it would build an embankment. Its position soon becomes unstable, and the slightest cause will divert it to a new bed, which it builds up in turn, and which in turn becomes unstable, and is also abandoned. The frequent repetition of these shiftings causes the stream to vibrate radially round the gate as a centre, and in the lapse of ages it builds up a half-cone, the apex of which is at the gate. The vibration is not regular but vacillating, like a needle in a magnetic storm; but in the long run, after very many shiftings, the stream will have swept over a whole semicircle, with approximately equal and uniform results. The formation thus built up is an 'alluvial cone.' . . . There is one feature which the eye seldom recognises or even suspects. The profiles are not truly conical, but are slightly curved, instead of having a truly rectilinear slope. They are concave outwards, the slope being a little greater near the apex, and slightly or sometimes insensibly diminishing towards the periphery. . . . † It is a surprisingly harmonious result of a process which in its elements is apparently irregular, and becomes regular only by averaging the results of its constituents. . . . The cone appears to be built up of long radial or sectoral slabs, superposed like a series of shingles or thatches."

This is the history of all deltas and alluvial cones. In the case of small fans, such as those that border alluvial valleys,

* Capt. Dutton, Geology of the High Plateaus of Utah, 1880, p. 220.

† Capt. Dutton finds the slope near the apex to lie usually between 2° and 3½°, while near the periphery it reduces to 1° or 2°. In the fans laid out at the mouths of streamlets on the sides of valleys in the North of England, I find the slope to range to 6° or more. But there is a perfect gradation in radial slope between the river-delta of fine mud in which the slope is some very low fraction of a degree, up to the talus of rude blocks in which it may exceed 35°. The flattening-out to which Capt. Dutton refers is of course due to the fact that the coarser discharges at the gate-mouth approximate more to the talus-condition.

the streamlet in fine weather often slips down one side of the semicircle, between the cone and the bank. When swollen with rains it pours straight over the apex, adds to it what of gravel it may carry, and splits into radiating runnels that shift hither and thither, building wherever they best can, and strained of their finer sediment by the grass.

The forces producing alluvial fans being in the condition of delicate adjustment described by Capt. Dutton, the periodical destruction of their margins through river planation at once upsets the equilibrium. When the stream finds the

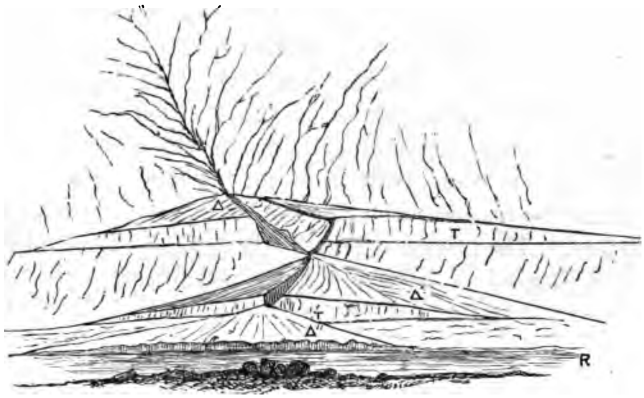


Fig. 15.

Fan Terraces (after F. Drew, Quart. Jour. Geol. Soc., vol. xxix., p. 454).

Δ Delta or Alluvial Fan shed from ravine on the side of a valley and cut by the river into a Delta Terrace at T ; Δ' Second Delta thrown out through the first, and also converted into a terrace ; Δ'' Third Delta spread on the existing river level, partly cut into at T' ; R, river.

edge of the river-bank where it was wont to find its own gentle slope, it pours over, cuts a gully back into the heart of the fan, and never again resumes its conical distribution of materials at that level without first building up to it. The old delta is left as a *fan terrace;* and successive interruptions of the fan-forming processes, which may be resumed at one level after another, if the river, in making its own terraced valley, should happen to prepare them, will result in a series of fans with their edges clipped off into terrace-fronts (see Fig. 15, in which the fans are small enough to be very distinct).

The distinctive characters of fan terraces are obvious—(1.) Their surface-planes slope radially away from the "gate." (2.) They are of equal height on the two sides of the stream issuing from it. (3.) Their terrace-fronts, as viewed from the main valley, tend to thin down at each end. They are best formed when a tributary enters upon the terraced side of a persistent bend. When the main river no longer encourages fan-formation, and the side-stream is allowed to work its way after its own fashion, it may of course set up its processes of planation and terracing within the heart of its own fans (see Fig. 16, in which the shaded surface is the plane of an old delta terrace).

Delta Terraces.

The fan terrace just described is the best exemplar of the terraces that may result from the movements of a river near its mouth. The valley which receives the tributary, and the coast-line which terminates the course of the river, are both alike liable to be arranged in stages of descent—the latter by subsidence, the former by erosion—so as to communicate periodical impulses to the stream which enters them. The formation of delta terraces and fan terraces, in fact, can be almost equally well pictured to the mind by means of Fig. 15. The delta in both cases is cut in two when the acceleration comes; the margins of the cut face each other at the same level, and the terrace-flats representing the two halves, or, as Chambers phrased it, the *wings* of the intersected delta, have the same outward slope and gentle arch.*

The greater size and gentler slope of delta terraces render them more liable than fan terraces to form "cone within cone." Hence they are more frequently complicated with other varieties of terrace. Upheavals alternated with periods of rest, such as produce old coast-lines, may each obviously result in a kind of *cycle* of river action containing three stages: 1st. The stage of the delta terrace (answering to that

* Strictly speaking, of course, the margins of the intersected delta have relation to this arcuated form of its transverse section. If, therefore, one of the wings were removed as far as its tip, while the other remained intact, the margins would *not* stand at the same level.

of upheaval); merging down (2d) into the stage of lateral terraces, as the stream begins to find lateral play (= the first period of rest); and (3d) the stage of a new delta-formation within the arms of the old, as the stream loses slope and grows enfeebled (= later period of rest). And then subsidence may recommence the cycle. The two later stages are necessarily accompanied by much destruction of previous terraces, and the complication must often be great beyond all possibility of disentanglement, more especially as the full cycle may be interrupted at any stage by fresh upheaval of the coast. The relative proportions of deepening and of planation that ensue must in all cases obviously depend on the rapidity of upheaval, the angles of the new gradients, the nature of the materials worked in, and the term of rest.

Not the least important phase of delta-terracing through repeated upheavals of the coast-line, is its tendency to extend itself inland. River valleys cut in soft materials may be fringed for some distance from their mouth by what are really *delta terraces produced.* "When the coast rises," says Professor Hull,* "the rivers are converted into rapids and waterfalls, which commence to cut back their channels inland, until a balance between the eroding power and the inclination of the river-bed is established. Meanwhile, the channel being lowered, the former alluvial flats are laid dry, and new ones at a lower level are constructed." There is much reason to think, however, that only in soft and somewhat uniform materials can this inland extension of delta-terracing take place. A bar of hard rock interposes a check, and acts as a regulator to prevent spasmodic deepening in the parts of the river lying above it. The facts of the case may be illustrated by a circumstance related in Sir Thos. Dick Lauder's graphic work on the Morayshire floods. In 1838 it was considered necessary to divert the course of the Dorback—a tributary of the Findhorn—across the neck of a deep loop in its course, and an artificial trench was accordingly dug, saving the stream a circuitous course of 730 yards. When the connection had been established the water poured over a clay bank in a waterfall 15 feet high. In four months thereafter the stream

* Phys. Geol. and Geog. of Ireland, 1878, p. 114.

had worked the waterfall backwards through boulder clay for more than 200 yards. In ten months it had extended its new and deeper course to the foot of a rocky ravine.* But there, as a separate impulse, its progress was checked. It added a little to the length of the ravine, and something, perhaps, to its steepness and liability to erosion, but the rock was a medium in which the individuality of the impulse was absorbed and lost. To this subject, however, we shall return. In continuous boulder clay, or soft tertiary deposits, there is no reason to doubt that impulses of the kind may be preserved for a considerable distance. The terraces thus produced, like the delta terraces into which they expand, are of equal height on opposite banks.

Gorge Terraces.

The "gorge terrace" of Hitchcock is one of which the writer has had no experience. It is stated to occur either above or below gorges, and to be "intermediate between the lateral and the delta (fan) terrace." It is higher than the lateral terrace, and in issuing from the gorge (or in rising up to it) seems to slope away to the normal elevation, somewhat after the fashion of a fan terrace. It does not appear, however, that there is any necessary room for the distinction between lateral terraces and gorge terraces. In narrowed positions streams rise higher, and, if formed and preserved at all, their terraces must be higher also. Thus during the Morayshire floods the heights attained by the river Findhorn, as given by Dick Lauder, may be tabulated as follows:—

Place.	Width of Stream in Feet.	Height in Feet.
Freeburn,	600	17
Dulsie Bridge,	60	40
Bridge of Ferness,	about 150	27
Bridge of Daltich,	82	31
Randolph's Bridge, Relugas,	8, widening to 70 or 80,	50
Logie,	about 240	28½
Esses, above Sluie,	narrow ravine	50
Craig of Coulternose, below Sluie,	185	15
Plain of Forres,	spread at large	comparatively shallow.

At Randolph's Bridge, after rising above the lip of the

* …shire Floods, 2d Edition, pp. 74-76.

gorge, the flood spread over the bank, and sent off some of its top-water in a side track. Even here, then, there existed some of the conditions for the formation of a terrace worked out, after the fashion described in treating of the amphitheatre terrace, by this little diverticulum.

We now pass on to a consideration of some of the circumstances of environment that bear upon the formation and preservation of river terraces.

Valleys, viewed in their relation to River-Terracing.

The course of a great river is distinguished by Mr Archibald Geikie into three regions: First, The *Mountain Track*, where the young stream, continually swelled by lateral torrents, dashes down mountain sides and through ravines. Second, The *Valley Track*, where its course is more leisurely, and its rockier parts exist chiefly as gorges between wider and more alluvial reaches of valley. Third, The *Plain Track*, where the river winds out upon alluvial plains, largely of its own forming, and often deposits more than it erodes.

In the mountain track streams generally occupy themselves in deepening their rocky V-shaped channels, and in slowly planing them—if the structure of the strata permit—into an increasingly flat-bottomed U. In the plain track, again, where the river so often winds aimlessly among its own deposits, and planation is limited to the spreading-out of materials in planes, the only chance of terrace-formation lies in upheaval of a coast having sufficient slope to communicate activity to the stream. It is in the *valley* track that terrace-formation can best be studied in active progress. The gorges of hard rock by which most valleys are more or less interrupted, divide them, as it were, into compartments, within the wider flats and softer sloping banks of which planation, by means of river-curves, is ceaselessly at work. Each of these rock-gorges, as in the case just cited from Morayshire, has checked the more rapid deepening natural to the softer strata above and below it, and the activities of the stream are spent in lateral movements.

In countries where the glacial period has left thick deposits

behind it, there exists a double reason for this division into gorges and compartments. In the North of England, where the observations made by the writer chiefly lie, nearly all the valleys date from before the glacial period (a circumstance common to Scotland, Ireland, and other glaciated countries), and still contain quantities of glacial deposits. Towards the coasts the bottoms of these old valleys are found to lie much below the present sea-level; and even at elevations extending beyond 1000 feet into the interior the country is tracked by drift-filled hollows branching as they rise, that lie deeper than the present water courses, and have all the characters of preglacial stream-channels. The face of the country was not so entirely changed, however, by the erosion and boulder-clay deposit with which the glacial period was accompanied that the rivers were forced to take up entirely new lines of flow after their return. The grouping of the ground remained the same. The same high grounds directed the drainage down upon the same general lines of hollow.

The streams, therefore, took their way over the surface of deposits under which their former channels lay more or less buried. Sometimes they chanced to regain a position almost mid-valley; more often they ran more or less to one side of the middle; not unfrequently they lost their way entirely. Their post-glacial excavations accordingly have been conducted; in the first case, entirely in superficial deposits, with variable reaches of the same on either side; in the second case, first in boulder clay, etc., and then in the rock of the old valley-bank; and, in the third, almost entirely in rock. It occasionally happens that in a single sweep of its course a stream may pass over all three.

It thus comes about that while the narrowing and broadening of the preglacial valleys was determined by the hardness, or if the term may be allowed, *denudeableness* of the rocks among which they were hollowed, the width of the post-glacial re-excavations has been determined mainly by their relation to their half-buried predecessors. Their wider basins answer partly to the compartments of the older valleys, and partly to spaces in [illegible] rer has encountered soft reaches of bou[illegible] upon the whole,

has produced a multiplication of gorges. The streams have generally strayed on to rock where the old valley was constricted, and have touched it at many turns and elbows besides.

The significance of all this as bearing upon river-terracing is immense.

1. The gorges having given the rivers leisure for planation in the soft glacial deposits of the basins above them, rivers are in this way often enabled to form breadths of alluvium too wide to be kept level. They have to work that part of the valley in *strips*, as it were, and the strips not in use are liable to be left high and dry. It will not be supposed, however, that the influence of gorges is always favourable to terrace-making. There are gorges so extremely durable that the movements of the river in the basin above them have been almost entirely lateral movements. In these cases the river may only prey upon its own deposits and older terraces.

2. The modern rivers, as we have seen, have struck rock at very variable depths. In hundreds of cases, after winding freely about, encountering only soft clays and the like, and constructing terraces of various kinds, they have here and there become rock-bound, and prevented from pursuing their work of terrace-building after their former manner, as well as from destroying the terraces they had already made.

These facts, which are of constant recurrence, will be illustrated by Fig. 16. The more recent of the terraces there represented are grouped within two compartments, separated by a few yards of rock, in which part of the stream has lain passive, while its neighbouring curves have been actively terrace-building. There was a time, however, when the rock lay untouched beneath boulder-clay, now to be seen overlying it in section at the corner, and when the stream was free to move over the surface of upper terraces, one of which is represented by shading in the figure. To the rock we owe the spit or spur of this shaded terrace that lies between the two compartments. There is nothing more interesting, of the kind, than to trace the history of the early movements of rivers at times when they flowed unrestrainedly above the rocks that now fetter their movements.

3. The valleys now presenting so variable a bottom, the streams have been the more encouraged to work into tortuous courses full of persistent bends and the amphitheatre terraces to which they give rise.

4. The restraint exercised by rock upon the modern rivers strengthens their natural tendency, of which sufficient account has not been made, to occupy narrower portions of valleys

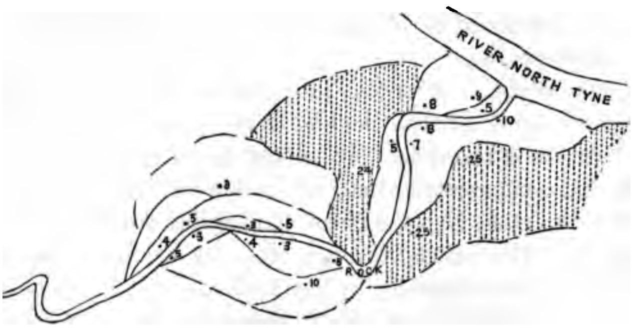


Fig. 16.
Terraces at mouth of Nunwick Burn (North Tyne). Figures denote points of elevation in feet.

the more they deepen them. It has been too hastily concluded, because rivers now occupy narrowed valleys flanked by terraces comparatively broad, that therefore they have vastly shrunk,—from dimensions, in fact, proportional to the greater breadth. But we must seek signs of diminution in other directions than the mere extent of area occupied by rivers in earlier times. The rapidity with which planation is effected is obviously greatly dependent on the height of bank and quality of materials. When, therefore, after the first bursts following upon the glacial period, the rivers commenced to work upon shallow wide-bottomed valleys, soft and yielding in their nature, except where crossed by bars of rock (and as such, in all cases with which we are acquainted, the glaciers left our northern valleys), they proceeded to plane far and wide, travelling from breadth to breadth to an extent never now equalled. Wi[illegible] now-a-days eight or ten times as high, and [illegible] times as many points, it is no [illegible] seem to have

"run *in*." It appears to be a law attending the travelling of river-curves, that, other things being equal, they shall flow by preference in parts of their valley where the curves can travel rapidly; for, if a river seek to thrust a curve into a rocky bank when it has the choice of a course through alluvium near at hand, other curves supersede the eccentric one, and the water is drawn away from it. Rivers, in a word, cannot but concentrate their channels as they excavate them, unless the amount of planation is out of all proportion to the rate of deepening.

5. The division of valleys into gorges and basins has tended to regulate and equalise the effects of spasmodic movements of elevation at the coast. It seems to be quite impossible, with that arrangement, that "as the sea fell from one level to another, so must also the rivers have fallen from one level to another." The cutting through of a rock-barrier in a river-course is not accompanied by any such spurts and stoppages as can produce marked stages of planation and repose in the basin above it. Pulsations and fluctuations there doubtless are. There are cycles in the meteorological causes that produce floods; there may be alternations of harder and softer rock in the barrier; and there are other variations, such, for instance, as when a waterfall has worked back to the edge of an alluvial flat, a circumstance which is doubtless productive of some leisurely acceleration in its excavation. The unstable equilibrium maintained by a river in the various parts of its channel, is, without doubt, liable to slight derangements (or re-adjustments) of many different kinds. But when the relations of a river to its bed are considered, the erosive impetus of the one seldom in two places the same, the variations of harder and softer in the other seldom equally resistant for many yards together, it is hard to escape the conclusion that the effects of these pulsations are lost,—like pulsations of all kinds, by travelling through a succession of varying media. Successive uprisings of the coast in these circumstances will have so blent their effects as to have in the interior the results of equable elevation.

When, therefore, it is assumed that "as the sea fell from one level to another, so must the rivers also have fallen from

one level to another," and that successive elevations of 25 or 50 feet at a time must have sent separate and defined impetus to points many miles inland, it is forgotten that, long before reaching so far, the 25 or 50 feet will have been distributed over dozens of rapids, pools, and waterfalls, adding here a little and there a little to their height or depth. To take, for instance, the case of the Tweed, the terraces of which Mr Milne Home has tried to explain upon this theory. At the present day an elevation of the coast at Tweed mouth would, to begin with, have twenty miles of windings to travel in shales and sandstones of the cementstone (carboniferous) series, through numerous pools and rapids up to Carham. It would then enter upon the basin to which the Kelso river terraces belong. At Makerston House it would traverse two miles of rock and gorge in the Kelso trap, and would then enter upon the series of persistent bends—not without their rock exposures, which contain the terraces of Merton House and Dryburgh Abbey. It would then encounter another rocky "narrow" of some two miles in length; and ere it could reach the terraces at Bower on the Gala Water, 700 feet above the sea, it would have travelled nearly the whole length of that branch of the Tweed besides. We might here refer to the twenty-two basins into which the Connecticut is divided, and ask whether subsidences could be supposed to travel more than 200 miles through all the varieties of arrangement which they present; but seeing that it might be maintained that a single waterfall would interpose a check to this assumed travelling, which it could not, practically, surmount, it seems unnecessary to carry inquiry further.*

* Let a lake-basin be supposed close to a cliffy shore, with only a few yards of rocky water-course, and a 20-feet waterfall between it and the sea. The water-course, like all others, will slowly deepen; the waterfall, as usual, will tend to recede; and the lake, by slow persistent processes, will, inch by inch, be drained. What now will be the effect of a 20-feet elevation of the coast? No necessary effect at all. The waterfall need recede no quicker than before; the lake need be tapped neither more rapidly nor less evenly. The case is in no way bettered, when, instead of a lake close to the sea, we have an alluvial basin twenty miles from it, and twenty miles of mingled rapid, gorge, and waterfall between. As a periodic impulse it may never reach the basin at all. A 50-feet stride of elevation is an extreme assumption as regards Scotland. Raised beaches exist a[illegible] [illegible]0 feet above the present sea-

River-Terracing in Miniature.—Conclusion.

Although there may be much unwisdom shown in applying the results of observations made in one small corner of the world to all other parts of it, yet it is fair to draw a distinction between isolated observations and essential principles. It was here that the strength of the Huttonian theory lay. The action of running water is in all times and places guided by the same principles.

To those who will humbly study nature, there is much to be learned from the miniature stream-terraces that may be seen on a sandy sea-shore when the tide has ebbed, or on sand-banks at river-sides, and on spreads of deposit sent from the mouths of drains during a thunder-shower. An instance of miniature-terracing, full of interest and suggestiveness, lately came under the observation of the writer. It was a small runnel, proceeding from a spring, some ten yards away, and flowing over a smooth beach of fine sand at the edge of a river. It is scarcely necessary to give full details of the operations of this little stream. It is enough to say that like larger ones it had its curves, its deflection-banks, at the base of one of which it was still scooping with a force that drove away a brush of sand-grains as if they had vitality in them; and opposite these little cliffs, it had its terraced slopes, left to one side because the stream had pushed to the other, and marked by the finest possible engraving of terrace-lines, *not* at equal heights where they chanced to stand opposite. These little amphitheatre terraces we watched in the forming.

In this case the supply of water was from a spring uniform in its outflow, under conditions in which it could not have been swelled by rains, or even diminished by the drinking of

level. I am uncertain how many of these, besides the 100 and 50 feet beaches, may have affected the Tweed. A raised beach of 15 feet exists at Holy Island. It may again be pointed out that terraces produced after this fashion ought to be in opposite pairs. And yet from Mr Milne Home's memoir itself, the Tweed terraces may be known to have, to a large extent, no such arrangement. To obtain successive flats, moreover, a stream must be supposed invested with powers of planation, which it would be absurd to suppose to be limited to horizontal excavation. The theory, in fact, concedes to streams powers which, with a sufficient slope to maintain flow, could dispense with pulsations of all kinds, except where they are proved.

cattle. We satisfied ourselves that all the essential effects of river-terracing had been produced by this streamlet:—

1. Without having been induced to fall from terrace to terrace by repeated falls in the level of the river.
2. Without having at any time filled its little valley up to the rim or base of its highest terrace, so that it might fall from terrace to terrace in subsiding.
3. Without having even flooded its valley to such an extent during the excavating of it, that its terraces were indented flood-margins.
4. Without having been sometimes glutted with sediment too abundant to remove, and at others permitted to intersect the surplus deposits.
5. But simply, by planation at different levels and to varying breadths, with a tendency to narrow the field of its operations as it deepened its course.

The existence of terraces is thus compatible with absolute uniformity in the water supply. The mere breadth of terraced valleys is no criterion of the volume of water that has occupied them, any more than the mile-and-a-half's depth of the Grand Canôn is a proof that it once held that impossibly vast column of river-water. The evidence of "pluvial" and torrential periods must be sought in other directions. In the valleys which we know best, the highest line of the river-gravels, 60 or 70 feet above the present river-bed, is not a terrace, but a shelving, shore-like slope.* It would appear that, in these cases, the first flowing of the post-glacial rivers was not attended by terracing. Their shores may have been heavily plated over with ice, a sort of ice-armour, warding off the attacks of the water. Or, more probably still, the rivers may have been liable, like some arctic and sub-arctic streams of the present day, to freeze almost *en masse*, thus being glutted with such vast bodies of massive

* It is necessary to distinguish carefully between the highest river-flats and approximate flats of some other kind which the rivers found made to their hand, and left here and there on either side of them. These, in this country, consist either of boulder clay or of glacial gravel. When Gumælius speaks of Norwegian terraces as being sometimes overlaid by moraines, it would appear that the terrace is not a river terrace, but of some antecedent kind.

or broken ice, that the water, unable to bear it away, had no choice but to break over the top, sweeping the shores with levelling violence. It is thus in the *non*-terraced portion of the valleys of Northern England that we seem to find traces of the most violent floods; and there is a very general concurrence of testimony that at these high levels the river-gravels are thickest, coarsest, and most tumultuous, besides being bouldered with blocks probably ice-dropped.*

To facts of this kind we look as the proper evidence of ancient floods. Their deposits must be proportioned to their magnitude. We have a right to expect, upon the extremést flood theories (such as are being more than revived at present in the pages of the *Geological Magazine*), that they should follow, upon a gigantic scale, the arrangements now presented upon a smaller one, scooping vast scars at the larger turns of valleys and accreting immense gravel banks opposite them, based on blocks of gigantic size. The effects of unwonted floods upon our modern valleys is no criterion of what would happen if great floods were not the exception but the rule. At the present day a large flood spreads pure devastation in a valley unprepared for it. It is like a force of 1000 horse-power brought to bear upon a machine calculated for but one hundred. The machine is shaken to pieces. But let the larger force be reserved for the greater machine, and all will go according to the principles of construction, and the ordinary laws of motion.

The opinion seems to be gaining ground among the younger geologists of America, that in North America, as in Britain, there was but one short torrential period which swept the valley-banks and left bare slopes for subsequent river-action to terrace. And the first question to be answered by the student of river terraces is being recognised as this: "In how far has the subsequent action been unaided river-action, resulting in terraces *not* opposite?" It is not allowable to have recourse to coast elevation, or climatic changes, or

* Professor Green remarks that the Yorkshire river-gravels are also coarser in the lower part of each gravel-bed. This seems to apply to river-gravels of all ages ("Geol. of the Yorkshire Coalfield," Mem. Geol. Survey, p. 784). See also Figs. 9 and 10.

periodicity of any kind, without first proving that the terraces range in opposite pairs. All elevation of the land has its ultimate effects upon rivers. It prolongs the term of their activity. There is the same manifest relation between the two that exists between area and population. It is scarcely thought necessary as yet, however, to connect increments of population with upheaval of coast-lines. Activity in both cases may be quite independent of coast-lines, if we but have, in the first place, a country fit to people, or to terrace. If it should ever be proved to the satisfaction of all geologists that the glacial period in this country closed, not during a submergence, it will be admitted that in the renewal of free drainage upon a country with fresh gradients, we have all that conduces to river-terracing as we now chiefly find it. It will probably be found, however, that the distinction into terraces in "closed basins" and open valleys or valley mouths is of much importance, and nowhere better marked than in Norway. When they are approached from the Huttonian point of view, the Norwegian terraces, which have already fascinated all geologists who have seen them, will perhaps, in so far as they are river terraces, receive a better interpretation.*

In this country, as in other northern lands, the *terrace period* is emphatically a post-glacial period. To the Ice Age we owe many features of lightsomeness and beauty in the face of the earth, and among them river terraces, which, beautiful themselves, seem constructed on purpose that we might the better view the beauties of valleys from them.

Like all other features of surface configuration they are only temporary. At first steep scars, then assuming the

* How narrowly this better interpretation has escaped Professor Kjerulf will be seen from the following quotation from one of his papers: "When the flat of a new-formed terrace is laid dry (by a jerk of upheaval), running water begins to cut into it; the stream meanders changefully to and fro, and makes among the terraces a broad course levelled out into an inclined plane; while of the terraces there may remain only traces far in towards the valley side" (Om Skuringsmaerker, etc., Christiania, 1871). Were this levelling only recognised as occurring in the middle and at the sides at different times, Professor Kjerulf would find himself enabled to meet Petersen's objection to his present views, that the coast has not always risen intermittently; and Gumælius', that the terraces are not always opposite.

slope of fallen material, they are, as time goes on, being washed and wasted into mere gravel slopes, like the obscure gravel platforms of the "high-level" gravels in the south of England. By the time they have become effaced, the gradients of the rivers will perhaps have become so low, and their powers so enfeebled, that we may not have others to replace them. One great beauty of our valleys will then be gone. Nature will no longer put in this artful touch of the artificial, until such time as the country enters upon a new phase of geological activity inducing corresponding activity in the streams. And so

"From side to side eternal swerving
They zig-zag on."

XXVIII. *Additional Notes on the Algæ of the Firth of Forth.* By GEORGE WM. TRAILL, Esq. [Communicated by Prof. DUNS.]

(Read 21st February 1883.)

Note of species new to the Firth of Forth, discovered during the year 1882, with exhibition of specimens.

1. *Herponema velutina,* J. Ag.—Parasitical on *Himanthalia lorea* at Pittenweem, Kilrenny, Crail, etc. (G. W. T.).

2. *Fucus distichus,* Ag.—Found cast ashore at Port Seaton, by Mr J. R. Henderson. Identified by Mr E. M. Holmes. New to Britain.

3. *Callithamnion corymbosum.*—Growing on muddy rocks at Joppa. Uncovered only at very low tides (G. W. T.).

4. *Gymnogongrus Norvegicus.*—Growing at Drummore, in pools at very low tides (G. W. T.).

XXIX. *On the Glaciated Summit of Allermuir, Pentlands.* By James Bennie, Esq., of the Geological Survey of Scotland.

(Read 18th April 1883.)

Some time during the spring of 1870 Dr Croll told me that he intended going to some of the higher slopes of the Pentlands to see how far up the ice markings of the glacial period extended, and asked me to help him. I readily agreed, and one bright morning we started for that purpose, duly equipped with compass, hammer to take chips, spade to dig for clay, and bag to carry the samples of each collected.

We went through the fields to Swanston, going round the farmhouse, up a defile, passing by the old village of Swanston, and so on to the flanks of Caerketton. The way was pleasant, and the suggestive talk of my companion made the walk delightful and piquant. Among other things we discussed the why and wherefore of our mission.

Dr Croll said he had been trying lately to account for and explain the condition of the boulder clay of Caithness, on the theory that it was, like all the other boulder clays of Scotland, the product of land ice. This theory he had applied to every circumstance and characteristic of the Caithness boulder clay, and found that it accounted for them more satisfactorily than any other;—nay, that the very exceptional one—the occurrence of fragments of marine shells throughout its entire mass—was not against his theory, but in favour of it—indeed, a main proof of its truth.

Caithness, he said, being a low flat country—little more than 30 feet above sea level—could not produce land ice of its own to glaciate it, but that very circumstance made it possible to be invaded and glaciated by land ice from other regions. That ice he supposed to be the ice which flowed outwards from the eastern slope of Scotland into the North Sea, or rather the hollow now known as the German Ocean, but which at that time could scarcely be called a sea, but rather a *mer de glace* filled with ice poured into it from the Highlands on its eastern and western sides. That ice would be certainly many hundreds of feet, perhaps some thousands

of feet in thickness, and would have no difficulty in filling to overflowing a basin which we know from the present depth of the German Ocean to have been only 200 or 300 feet in depth. The ice-streams coming from opposite directions would meet and press against each other with a force proportional to the impulse each had. The ice from the eastern side—that is, from the highlands of Sweden and Norway—would be far greater in amount and power than that which flowed in from the western side—from the Highlands of Scotland, just as the area and height of the Scandinavian mountains surpass those of Scotland. In consequence of the superior volume and force of the Scandinavian ice, the ice which streamed out from Scotland would be pushed back upon itself, and forced to heap itself up against the land, and if the land was low, to override and pass over it, carrying with it all the *débris* of mud or stones it had originally, or had picked up by the way. This theory was confirmed by the stones found in the boulder clay of Caithness. Many of these were known, by the researches of Mr Dick of Thurso and Mr Charles Peach, to consist of chalk flints and fragments of oolitic limestone, which had come from the southern shores of the Moray Firth, and which could only be carried to Caithness by ice flowing from thence, and crossing over the basin of the Moray Firth, from which also it could easily get the shells so abundantly scattered through the Caithness boulder clay. This was the theory which Dr Croll applied to the solution of the problem, and it fitted into all the circumstances of the case so completely, that he had no doubt of its truth.

But it was with only one consequence of this state of things that we are concerned at present. This was, that the Scottish stream of ice having been met with one greater in volume and force than itself, would be dammed back, or heaped up, as it were, till it rose to a height almost equal to that opposed to it, and of course, as the Scandinavian ice was many hundreds of feet in thickness, the Scottish ice would be almost as thick, and would be piled up upon the land ti it overtopped the highest hills on the eastern slope of land. Now, if such a result had taken place in th

period, evidence of it might yet exist on the sides or slopes of say the Pentlands, and it was to search for such that our excursion was projected. This idea, given with all the force of language and aptness of illustration of which Dr Croll was capable, imparted a zest to it which inspirited me to brave the stey braes we had to surmount to verify it. My companion proposed that we should go first of all to the very top of the hills, and if we found them glaciated that would prove at once that the ice had reached that height at least. We therefore set ourselves to climb the two highest peaks of the east end of the Pentlands, called Caerketton and Allermuir, respectively 1600 and 1618 feet above the level of the sea. We ascended Caerketton first, but found the top a mass of stony *débris,* recently made by the weathering of the rock of which the top consists—a volcanic breccia which frosts could easily split and divide. We looked for glacial striæ on some of these fragments, but found none.

We then descended into the hollow between the two hills, and climbed up to the top of Allermuir. We found the top to be only a few square yards in extent—partly in grass and partly bare rock. We turned to the rock first and saw that it was a hard red porphyrite, quite capable of receiving and retaining striæ, and we eagerly looked over the exposed surfaces. At first we found nothing, the surface was too fresh, having been recently formed by fracture from weathering. We then examined the fractured pieces lying loosely about, and very soon found some which had unmistakable striæ upon one surface. These, we concluded, had formed the original surface of the hill top very recently. Looking round we saw signs that the hill top had been purposely bared—the turf having been taken up to be built round a signal pole for triangulation. Encouraged by this success we then sought the original surface *in situ,* and putting the spade into requisition, we soon uncovered a portion, and found it smoothed and as finely striated as it could possibly be. On the very top of the hill was a small space, perhaps a square yard or so, which showed not rock but earth. Into this I struck the spade, and dug till I came at the depth of a foot [illegible] earth I turned up was full of

small pebbles, and might be considered a kind of boulder or stony clay. A portion was immediately bagged for washing and examination afterwards. The rock surface beneath the earth was, as I have said, finely smoothed and striated, and having cleared and dusted two or three square feet, the direction of the striæ was taken by compass, and made out to be a few degrees north of west. From the mouldings of the surface we concluded that the ice which had polished and scratched it had come from the west and gone to the east. On examining the rock we had just bared we found it cracked in various directions—doubtless by recent weathering since the turf had been removed, and with little difficulty we loosened a small portion of it, and lifted it up and bagged it. This was afterwards set in Portland cement, and is now on the table for the inspection of the members.*

Having thus successfully accomplished our mission, I shovelled the earth back into the hollow again, my heart humming Eureka, not loud but deep, befitting the occasion. As a fierce north wind was blowing strongly over the hill top, we slipped down a few yards on the south side of the hill, out of the wind and into the sun, which was shining brightly and pleasantly warm, and discussed our lunch and the facts which our discovery proved. The summit of Allermuir, my companion at once concluded, could have been glaciated only by ice that had overridden it. That fact there could be no gainsaying—ice in motion being the only agent in nature capable of polishing and striating rock surfaces such as we had just uncovered. If ice, then in what form? Was it sea ice—in floe or berg—or coast ice? The answer was no, decidedly no;—the reasons for which, as Dr Croll had studied the question thoroughly, he readily recited to me, and which may be found set forth at length in the twenty-seventh chapter of his work on "Climate and Time." Land ice was then suggested—not, however, as glaciers formed on hill slopes and flowing down valleys as in the Alps, but land ice in the form of a sheet covering the whole face of the country—hill and valley alike, as is seen in the case of Greenland—and flowing like it from a centre of dispersion

* It may be seen in the Edinburgh Museum of Science and Art.

outwards to the sea on all sides of Scotland. The centre of dispersion in Scotland would, of course, be the highest parts of it—the group of its highest hills, the Grampians, and the high land surrounding them. There the snowfall then, as the rainfall now, would be greatest; and as the snow accumulated and became, as its habit is under pressure, glacier-ice, it would flow outwards on every side towards the lowest levels it could find. On the western side, the slope being short and steep, it would speedily reach the sea, but on this, the eastern side, the slope being low and long and the country wide, the greatest outspread of ice would necessarily occur. At first, in the beginning of the glacial period, the ice sheet would not be very thick, but as the glacial conditions became more intense, the greater quantity of snow that fell in the longer winters would have less heat to melt it, as well as less time to be melted in the shorter summers, and the ice would grow thicker and thicker, and flow farther and farther outwards, year by year, till it not only spread over all the low grounds, but even invaded the North Sea, till its advance was checked by the stream of Scandinavian ice coming from the other side as already explained. The obvious result of such a check would be to cause the ice streaming out from Scotland to be banked upon it, till it swallowed up and overrode, first all the lower, and finally all the higher hills, on the eastern slope.

Such seemed to us the only method by which we could suppose the top of Allermuir to have been glaciated, and the stony clay to have been deposited in the little hollow on its highest point.

Having reached thus far in our cogitations, we crept up to the summit to look again at the scene around us in the new light we had got upon it. The day was fair and bright. A high and dry north wind was on in full blast, the air in consequence was free from mist, and we could see far away on every side.

On the south we looked into the heart of the Pentlands; great steep hills rose up on every side, with narrow deep hollows between; in one or two water glimmered bright like silver in the [illegible] sides of all the grey grass of

winter was becoming deeply green, as the phosphorescence of spring was deepening into the emerald glow of summer. On the north-west the Ochils rose up huge masses of cloudlike shadow, overtopped here and there by the greater Grampians behind. Naturally, however, we gazed longest at the wide expanse of landscape, stretching from the foot of the hill we stood upon away over the broad lowlands of Midlothian—the Firth of Forth gleaming bright in the sunlight, the higher lands of Fife dominated by the peaks of the East and West Lomonds—and beyond them on to the far horizon, broken by one solitary blue hill, which we supposed to be one of the Grampians of Forfarshire, more than sixty miles from us. Over this fair landscape the greater mass of the ice of Scotland streamed outwards in a sheet greater in depth than the hill we stood upon was high, and wider in extent than the whole range of country we could take in at one view. To imagine in any adequate degree the aspects of that time, or of the scenes which took place in the area before us, we felt ourselves utterly unable, and that here as elsewhere in geology, "reason could lead where imagination dare not follow," and we could only conclude, in Dr Croll's own words, that "this broad plain—extending from almost the Southern to the Northern Highlands—was the great channel through which the ice of the interior of Scotland found an outlet into the North Sea. If the depth of the ice in the Firth of Forth, which forms the southern side of this great broad hollow, was at least 1900 feet, it is not probable that its depth in its northern side, formed by the valley of Strathmore and the Firth of Tay, which lay more directly in the path of the ice from the North Highlands, could have been less. Here we have one vast glacier, more than 60 miles broad and 1900 feet thick, coming from the interior of the country." *

One other paragraph from "Climate and Time" will fitly close this note. On the question—Why the ice of Scotland was of such enormous thickness, Dr Croll says: "The enormous thickness of the ice in Scotland has been a matter of no little surprise. It is remarkable how an island, not

* "Climate and Time," p. 441.

more than 100 miles across, should have been covered with a sheet of ice so thick as to bury mountain ranges more than 1000 feet in height, almost at the sea-shore. But all our difficulties disappear when we reflect that the seas around Scotland, owing to their shallowness, were, during the glacial period, blocked up with solid ice. Scotland, Scandinavia, and the North Sea would form one immense tableland of ice from 1000 to 2000 feet above sea-level. This tableland would terminate in the deep water of the Atlantic by a perpendicular wall of ice, extending probably from the west of Ireland away in the direction of Iceland. From this barrier icebergs would be continually breaking off, rivalling in magnitude those that are now to be met with in the Antarctic Seas." *

XXX. *On the Occurrence of Selenium in Commercial Sulphuric Acid, and its Action on Mineral Hydro-Carbon Oils.* By James C. Hamilton, Esq.

(Read 21st February 1883.)

Before entering into the subject of the action of selenium on mineral hydro-carbon oils, it may be not uninteresting to some of the members present, if I were to give a short sketch of the production and manufacture of these oils, and the manner in which selenium would be liable to affect them.

The shale from which the oil is produced is brought directly from the pits or mines where it is found to the retorts. In this state the sizes of the pieces of shale are very unequal; and to make them of a comparatively equal size, and also to enable the oil vapours to escape more easily, the shale is put through what is known as the "*breaker.*"

From the breaker the shale is put into the retorts. Various kinds of retorts are used, the three commonest forms being the Henderson Patent, the Vertical, and the Young & Beilby, all possessing attributes suitable to the different kinds of shale. In all these retorts, steam, either superheated or soft,

* "Climate and Time," p. 452.

is used. The products of this distillation are oil, ammonia water, and an uncondensable gas, which latter is brought back to heat the next charge of shale. The ammonia water is separated from the oil, and by one or another means the ammonia in it is converted into sulphate of ammonia.

The oil more particularly concerns us. From the receiving tank of the retorts it is pumped into a charging tank, and from this charging tank it is run into stills, which are generally known as the "*crudes.*"

In this distillation, as in all distillations throughout the process, varying percentages of steam are used. The distillate is only slightly fractionated, naphtha being separated. The oil is now known as "*once run oil.*"

From the receiving tank of the crude stills the oil is pumped into a washer; a washer being a suitable vessel, able to contain from 500 to 7000 gallons, the contents of which may be stirred either by air or by some mechanical means. On the oil in the washer sulphuric acid is run, and the contents agitated as long as is necessary to saturate the acid with tar. This tar is run off, and a second quantity of acid is added. In like manner this also is agitated, allowed to settle, and the tar run off. This process is continued until all the tar, which it is advisable to separate at this stage, is carried off. At the end of the last agitation the oil is allowed to settle for about three hours, in order to allow the tar more completely to separate. After settling for this length of time, the oil is run into what is known as the soda washer, where it is treated with a strong solution of caustic soda, in order to neutralise any acid which may be left in the oil, and to prepare the oil for another distillation.

From the soda washer the oil is pumped, blown by means of air pressure, or run into the second stage boilers or stills; from these stills it is fractionated into a light portion, specific gravity about decimal 828, which contains little or no solid paraffine, and a heavier portion, specific gravity about decimal 877, which, at 60° Fahrenheit, is solid with paraffine.

The *light* portion is taken and treated with acid and soda, as before, and is then again distilled. The distillate is fractionated into decimal 84, decimal 85 oil, and oil at about decimal

805 specific gravity. It may be as well to mention here, in order to avoid repetition, that the heavy fractions at the end of light oil distillations are mixed with the light fractions at the beginning of the distillation of the heavy portion, and thus carried on to the finished state. Thus, the decimal 84 to 85 oil is mixed with the decimal 84 to 85 oil from the beginning of the distillation of the heavy portion, and they are both washed together, and then form what is known under the various names of *marine* oil (from its application to ships' lamps), mineral colza, or under the commonplace title 840/50 oil. It is somewhat a waste product, perhaps its principal use at present being 840/50 Bloomless for the adulteration of rape and other high-priced vegetable oils. If the decimal 805 fraction is wanted as "*crystal oil*," it is treated with acid and a *weak* solution of soda, and after a washing with water it is ready for the market.

If it is wanted as No. 1 burning oil, it is washed with acid and a strong solution of soda, again distilled, and without treatment it is ready for the market. This process may seem curious, but the idea is to get as good a light from the No. 1 burning oil as from crystal oil, without the same crusting of the wick occurring, as in crystal oil, due to the presence of minute traces of sodium sulpho-olefines.

The *heavy portion*, containing the solid paraffines, is taken in a liquid state to the paraffine sheds, where paraffine of a melting point about 118° Fahrenheit is taken from it by means of a freezing machine, filter presses, and hydraulic presses. This crude or green scale contains about 4 per cent. oil and 2 per cent. dirt and water, and is the substance most largely used in the manufacture of paraffine candles.

The oil pressed from this green scale is known as blue oil and after the separation it is taken and treated with acid and soda as I have previously described. From the washer it is pumped into what are known as the lubricating or "*lub*" stills, and is there fractionated practically into decimal 865 and decimal 885 oils. I may mention that, in order to bleach the oil, it is treated with solid caustic soda in the stills—that is, solid [illegible] the still in order that it may

bleach the vapour as it is formed. These 885 and 865 oils are either washed with acid and a weak solution of soda, and thereafter the low melting point paraffines separated, or the paraffines are first separated, and they are then washed. The paraffine from the decimal 865 oil has a melting point of about 95° Fahrenheit, and that from the decimal 885 oil of about 100° Fahrenheit. In order to separate these paraffines, the oil has to be frozen down to about 18° Fahrenheit.

We now come to the action of selenium upon the oils. About two months ago, in the Uphall Oil Company's works, a discolouration was noticed in some burning oil in the process of manufacture, and before long the same discolouration was noticed in the whole of the oils, both heavy and light. There are many things which might have caused this discolouration, among others, under-treatment with vitriol in the first stages, or vitriol which contained nitric acid as an impurity being used in the later stages. In order to prevent confusion hereafter, I shall call sulphuric acid by its commercial title, vitriol.

As in these works the first of those causes was carefully noticed and prevented, this cause was at once put aside; but in regard to the latter, we were not equally certain. The vitriol from our stock gave decided traces of nitric acid, and of course we at once blamed that impurity; but as we are supplied from two vitriol works, it could not be decided, till further supplies of the acid arrived, who was the erring party. Next day two tanks of vitriol came in from the different makers. One of them showed distinct traces of nitric acid, with both the ferrous sulphate and indigo tests. The other gave the indigo but not the iron test. They both were of course at once rejected, but the second is the one with which we were more particularly concerned. Why it should give the indigo and not the iron test was rather a mystery. On receiving our notice of rejection, the makers at once sent out and sampled the acid, and thereafter sent the sample to an Edinburgh chemist, who reported that it only contained decimal 005 per cent. of nitric acid by the nitrometer, an instrument which I had not by me at the time.

This result puzzled us considerably, and we went on using

the acid, attributing the bad colour in the oils to a tank of the other maker's vitriol, which by some inadvertence had been allowed to pass into the refinery. Three days were allowed to elapse, when, in place of the oil getting better in colour, it grew worse. The supply of both these makers' acid was then stopped, and an acid which we knew to be pure used in the refinery.

I told my friend Mr Hunter of our difficulties with the oil, and of my opinion that there was something seriously wrong with the acid, which had given the indigo and not the iron reaction. He advised me to bring in a sample, and we would examine it together. One of the results of this examination was, that it contained practically no nitric acid, and yet it gave the sulphate of indigo reaction. The other result was, that there was something foreign in the sulphuretted hydrogen precipitate, as it was reddened to a considerable extent. A portion of this precipitate, with gentle heating, almost completely dissolved in ammonium sulphide, leaving a very slight black residue, which was at the time thought, and afterwards proved to be, lead. Another portion was boiled with ammonium carbonate, when the yellow arsenic sulphide dissolved, and left a reddish brown residue, which was reduced by the action of stannous chloride. This strange residue was at once put down as the cause of our oil going back in colour, but we had not at that time sufficient leisure to go into the matter further.

In the meantime our oil had come back to its original colour, with the acid which we knew to be free from any impurities, and this of course almost conclusively proved that there was no fault in the process. But, in order to further prove that it was the faulty acid which had done the damage, it was again allowed into the refinery, when the same symptoms were noticed.

As this could not be allowed to go on, an official sample of the acid was sent to Mr King and Mr Hunter, when they in a few days reported that the only thing that was peculiar about the acid, was the presence of an element resembling selenium, and which they thought was selenium. On further examination was conclusively shown to be

selenium, and, further, that it had a very injurious action upon oils.

This property of selenic acid, the state in which there can be no doubt the selenium exists in the vitriol, of acting upon mineral hydro-carbon oils, has, as far as I am aware, never before been noticed,—the usual bugbear being nitric acid, which, in the case of this vitriol, was shown to be entirely absent. What its exact action is, is rather difficult to say. But the most likely explanation of its action is, that during the process of treating the oils with vitriol, it forms a selenated olefine, which, during the washing with soda, is converted into a sodium-seleno-olefine, and this body on exposure to air, either reddens in colour itself, or acts on the oil in such a manner as to give it a red colour. This is, we know, what happens with sulphuric acid when the oil is overtreated. But, in the case of overtreatment with sulphuric acid, the evil is almost completely removed in the next distillation, while, with selenium, it is not, as the selenium compound distils over along with the oil, and dissolves in it. This was particularly noticed at the worm ends of the burning oil stills, where, when the oil should have been white, it was yellowed to a considerable extent.

This occurrence of selenium in sulphuric acid, and its action upon oils is as important as it has hitherto been obscure. *Important*, in so far as by its presence thousands of gallons of oil have been practically rendered unmarketable, and so *obscure* as to have misled the foremost of our oil works' managers, and the leading chemists in the oil industry. In the benefit accruing to the oil trade from this investigation, *personally* I claim but little, but, at the same time, there can be no doubt that the results are of the greatest importance, not only from an *intrinsic*, but also from a *scientific*, point of view; and if, in the credit that is going, I am only bracketed with Mr King and Mr Hunter, I shall be more than repaid for the part I have taken in the inquiry.

XXXI. *On a New Species of Octopus* (O. maculosus). By W. E. Hoyle, Esq., M.A. (Oxon.), M.R.C.S., F.R.S.E., Naturalist to the "Challenger" Commission. [Communicated by F. E. Beddard, Esq., M.A. (Oxon.), F.R.S.E.]. [Plate VI.].

(Read 21st March 1883.)

The specimen upon which the following description is based was placed in my hands, with a label, bearing the single word "Australia," and this is all the information I have hitherto been able to procure with respect to its habitat:—

Description of the Specimen.

Dimensions.

Total length,	10 cm.	
Length of the body,	2·75 ,,	
Lengths of the arms.	Left.	Right.
1st.	5·75 cm.	6 cm.
2d.	4·5 ,,	5·75 ,,
3d.	5·75 ,,	6 ,,
4th.	6·5 ,,	7 ,,
Breadth of the interbrachial membrane,		1·5 ,,

The lengths of the arms and the breadth of the interbrachial membrane are measured from the margin of the oral aperture.

The Body (Pl. VI., Figs. 1, 2) is subglobular, smooth, quite devoid of cirri or tubercles, the mantle-opening reaching about one-third round its circumference.

The Head is small, not very definitely marked off from the body; eyes rather prominent.

The Arms are subconical, of medium unequal length, their order in this respect being 4, 1 = 3, 2.* They are armed with small suckers, the innermost three or four being arranged in a single row; the suckers are so deeply imbedded in the sub-

* Since this paper was read I have ascertained that there are four specimens, apparently referable to the same species as the one here described, in the Liverpool Free Public Museum, and Professor Herdman has been good enough to send me the following note on the relative lengths of their arms:—

A. 3, 4, 2, 1 on one side of the body; 4, 2, 1, 3 on the other.

B. 3, 4, 2, 1 on both sides.

C. Arms much curled and stiff; probably 3, 4, 2, 1 on both sides.

D. 2, 3, 1, 4 on one side; arms too much curled on the other to make out with certainty.

From this it would appear that the formula is 3, 4
to variation.

stance of the arm as scarcely to rise above its surface. Their numbers on the different arms are—

	Left.	Right.
1st.	60	69
2d.	38	71
3d.	61	47
4th.	74	70

The second arm on the left side has been mutilated, whence its shortness and correspondingly small number of suckers. The third arm on the right side is hectocotylised (Pl. VI., Fig. 3); the interbrachial membrane is produced along its posterior margin in the form of a narrow rounded fillet. Beyond the last sucker the arm is rounded and conical for about 0·5 cm., while the extreme end is moulded into a small spoon-shaped apparatus 0·25 cm. in length; the central portion is smooth, flat, and surrounded by a slightly raised margin.

The Colour (after long preservation in alcohol) is whitish-grey, with brownish-black patches so well pronounced and definite in form, that one is forced to believe they are permanent and distinct from those changes in colour for which these animals are so remarkable.* On the upper surface and sides of the body are (20-25) oval annular patches about 2 mm. in length by 1-1·5 mm. in breadth; the ring presenting a dull grey semi-transparent appearance, while around and in the centre of it a lens reveals minute brown dots (chromatophores), which become less numerous as one recedes from the ring. At a little distance the effect produced is that of a large oval patch with a black centre, and gradually shading away towards its margins. Similar spots occur on the upper surface of the head and on the external and lateral surfaces of the arms, as well as on the outside of the interbrachial membrane. On the arms they form transverse bands, of which there are ten on the longest; the bands being for the most part rather more than half as wide as the light-coloured spaces which separate them.

The Mandibles present no noteworthy peculiarities.

The Radula (Pl. VI., Fig. 4) consists of seven series of teeth. The middle tooth of each row, when freshly de-

* The specimens in the Liverpool Museum show the same distribution of colours.

veloped, has a long pointed median process, on either side of which are two denticles. On either side of this tooth is a much smaller one, about one-third as wide, with a single point situated near its outer margin; and beyond this again is a tooth slightly broader than the median one, with a single denticle near its inner margin. The teeth of the outermost pair are long, slender, and gracefully recurved; externally to them are placed a series of rectangular plates.

Of the comparatively few radulæ of the genus *Octopus* which have been figured, the one in question recalls that of *O. vulgaris,* as delineated by Troschel;* but there the median tooth has only one denticle on either side, while in the next succeeding members of the radula the apex of the tooth is much nearer their centre. The radula of *Octopus Bairdii,* Verrill,† has a median tooth with no lateral denticles; but the two medio-lateral series present a considerable resemblance to those of the present species.

With respect to the affinities of the animal just described but little can be said; the form which approaches it most nearly seems to be a small species described by Quoy and Gaimard‡ under the name *Octopus lunulatus,* but, so far as I can discover, never since observed.

It was characterised by very definite circular markings, which were of a blue colour, and were in the form of raised rings, with a tubercle in the centre. There were also circular markings on the inner surface of the interbrachial membrane, which are entirely absent in this specimen. Further, the upper surface of *O. lunulatus* is covered with tubercles, whereas the present species has none of these.

That these differences are not due to the fact that my specimen had been preserved in alcohol may be seen by reference to the description given by d'Orbigny of Quoy and Gaimard's specimen, after it had been similarly preserved.§

* Ueber die Mundtheile der Cephalopoden, Archiv f. Naturgesch. Jahrg. xix., Bd. i., p. 1, 1853.

† The Cephalopods of the north-eastern coast of America, Trans. Connect. Acad., vol. v., pt. 2, pl. xlix., fig. 4.

‡ Voyage de l'Astrolabe, Zoologie, t. ii.

§ Férussac et d'Orbigny, Hist. Nat Acétabulifères, p. 59. Paris, 1835-48

He also mentions the tubercles and the distinctness of the coloured circles, of which he says, "ceux-ci se conservent en relief sur la peau."

EXPLANATION OF PLATE.

Fig. 1. General view of the animal from the oral surface (nat. size).
Fig. 2. Lateral view of the body and head (nat. size).
Fig. 3. The hectocotylised arm (magnified 3 diameters).
Fig. 4. The radula (magnified 90 diameters).

XXXII. *On the Discovery of Late Glacial Implements in the Rhins of Galloway.* By WILLIAM GEMMILL, Esq., M.B., C.M. [Communicated by A. MACCONNOCHIE, Esq.]

(Read 18th April 1888.)

Five or six years ago Mrs M'Gaw of Severil, who has given much attention to antiquities, gave me two flint implements which she had found in the vicinity of her residence. In a few weeks in the course of professional visits nearly a hundred were collected between Creechan and the Mull of Galloway. Later, when over a thousand chipped flints had been gathered, and their aspects in different localities had become familiar, it seemed strange that, if the current nomenclature of such relics were to be followed, and its implications deemed correct, especially with reference to certain forms of "scrapers," "saws," etc., then in some of the groups there would scarcely be a single implement that had been a projectile; there would neither be arrow heads nor heads of javelins, certainly a curious state of matters. Further, most antiquarians would look upon the work on the specimens as being chippings made by neolithic man. But those tools I had seen that were undoubtedly neolithic, such as polished celts, had been found in different localities from the ones in which these merely chipped flints were. A line of inquiry was thus started, in pursuing which I have handled not only several thousands of flints chiefly from the parish of Kirkmaiden, but others also from the parishes of Stoneykirk, Old-Luce, Inch, Portpatrick, Leswalt, and Kirkcolm, and have tracked out the chief localities in which they are found, meantime taking note of such indications as could be obtained regarding their relative ages. A rough general sketch of the

main results of this inquiry might prove interesting, and all the more so as it seems that many of the specimens must be relegated to a hoary antiquity in so far as some, water-worn or broken, and crusted more or less, have been found stratified in sands and gravels and tills which skirt the coast from the height of 400 ft. downwards. Implements, not by any means the worst found, and some of them very elegant even, have been extracted by me from the cut faces of nearly horizontal beds of tilly and bouldery stratified gravel at heights of from over 150 to 100 ft. on the heughs above Carrickamickie, at the Biawn, and the Old Mill, and on those overlooking Dunorroch and Carrickgill Rigging. In the 100 ft. stratified series fine implements have also been obtained, as for instance in Mull Glen at Youchtrie Heugh, Portankil, Kiliness, Low Curghie, in the Clanyard Kilstay ancient channel, between Grenan Wood and Terally, at Auchness, as well as inland at Stoneykirk and at the head of Luce Bay where the same terrace of sands and gravels, that formed the sea bed in the time of the 100 ft. shore, is exposed. In Curghie Glen, at a height of 150 ft., sands, and higher up other sands and fire clay, are found overlying the two deep sheets of till, under which the rocks are much fractured and crushed, while over the sands there is a thin sheet of the boulder filled surface clay. Where this clay and the various sands and gravels underlying it are absent, a still older group of implements, the 225 ft. group, is exposed. These have been found, thus, down to about 50 ft. above the present sea-level. Their area has tongue-like projections down the glens. They spread upwards, in some localities only, to a height of about 350 ft., and in a very few even higher. Part of them may have originally belonged to gravels and sands at a height of 275 ft. (at least specimens like some of them have been exhumed there). In that case they would have preceded the glaciers that slipped into the sea on a 225-ft. shore, and their occurrence down to a height of 100 ft. would be explicable enough without resort to the displacing power of ice. But it is questionable if those found in the 275-ft. sands and gravels are not older than these. Enough have not yet been turned up to enable the determination to be made. Within the last

few days, on the higher heughs between Knock Knowe and Port Mona, in dense red tills and bouldery and tilly gravels between the heights of 125 ft. and 350 ft., and more particularly at about 125 ft., 225 ft., 275 ft., and 300 ft., I obtained a number of well-wrought flint implements. The beds in which these were found were certainly the products of intensely glacial conditions. Some of the implements apparently resemble forms found in very ancient mammaliferous cavern deposits as in Kent's Cavern and Brixham Cave, a report of the discoveries in which last Mr Pengelly has kindly forwarded me. These wrought flints may yet have to be relegated to the earlier quarter of the ice age rather than to the later beds in which they are now found distributed. The cave fauna could never have existed at the time when these boulders, gravels, and dense hard tills were left where they are found. Either the cave implements, like them, are recent in comparison with the mammals, or the higher stratified ones on the west of the Rhins must have been fashioned in a period antedating by over a quarter of a million of years those implements that I have already relegated to the glacial age. Some of the stratified implements found at the Wild Cat Holes were in gravel that overlaid the broken down caves. The same was the case with what seems the remains of another high-level cave north of Port Mona, the whole arch of the cave having been removed. These caves may have been of the age of the glacial ingress, and have been there when land stretched far to the west where, now, is the deep sea. In that case they might contain remains of some old dwellers who lived there before the sea rose hundreds of feet over them, and left them bared again, but now on the edges of frowning cliffs. Implements of different types are also found on the high grounds separated by thick beds of peat, and accompanied by teeth of somewhat distinct groups of animals. Such an instance occurred at the Mull where the lower implements and teeth were resting on sand at the very bottom of the peatmoss. Remains of different species of deer are found in the deposits following the 100-ft. series of sands and gravels. In these instances the different relics become apparently mingled where the peat or alluvi

thins out. And so where no surface deposits occurred or where denudation had swept them away, tools may be found seemingly intermingled—that were once distinct and separate. Part at least of the relative abundance of flints on the sandy tracts of the raised sea-bottoms, not only in gravel-pits, but also on the general surface, is due to the facility with which sand is removed, having allowed once separated layers of relics to subside on to the same area of exposure. In some localities where a dividing band is present the implements above and below it have so different characteristics that those found apparently mingled beyond can be quite easily distinguished and their relative ages determined. Once the key to the distribution was known it was easy to foretell with perfect accuracy the very beds and heights in which the different groups would be found represented. Desultory searching was then changed for methodical and systematic work, and in a few minutes more could be obtained than were got in the course of days previously. A peculiarity of the old implements is that they are not stratified most abundantly under those parts of the surface on which tools of a later pattern are found in the greatest numbers. If there be many implements in the talus at the foot of a sand and gravel face (the cutting at Low Curghie road, for instance) a careful search will likely reveal them in the face likewise, firmly embedded and perhaps with the merest point of them exposed to the light of day, or, it may be, so loosened that they are about to drop into the talus below.

The implements are not by any means scarce, and I have not hesitated to give a number as well as plans of their sites to visitors who were interested in them. Some have thus found their way into the hands of antiquaries of repute who invariably called the arrow-heads of the Low Curghie group (75 ft.) "duck bill knives;" the Mull or Kilstay group of ridged straight or curved or even twisted lanceolate (100 ft.) ones "scrapers," or "saws" "without the teeth having been cut;" while the broad, flatted, laterally barbed (150 ft.) Sandy Point group, and the flat triangular ones found at High Drummore (225 ft.), were called "flakes." These are *all* late
'nd hence the repugnance, when they are

thought to be neolithic, to classing them with the barbed and leaf-arrow tips, and hence also any other name is accepted as the sailor chooses any port in a storm. An unprejudiced examination of a large number and of the conditions in which they are found would at once dispel these erroneous views. And though broken or spoiled flake arrow-heads have, in many instances, been undoubtedly used as scrapers, or manufactured into saws and drills, yet such is the case also with barbed "elf-shots." Though one or two of the old arrow-tips may be found fashioned into finely toothed saws, it does not follow that the innumerable others which are not were meant to be so, any more than a finely serrated barbed arrow-head found about Tors by the Rev. Mr Wilson proves that all others were meant to be serrated had the workers had time. Many of the old arrow-heads have undoubtedly been employed as scrapers, but the vast majority have not, and have the same general outline as a very much more finely chipped series belonging chiefly to other parts of Wigtownshire, only a few having been got here, and which unmistakably bear the appearance of being much elongated, very neat, finely chipped leaf arrow-heads. All the barbed, and perhaps also all the finer leaf, arrow-tips found here, so far as can be seen, belong to a later date than the 100-ft. series of deposits, and have originally been left on the old surface soil or in its coverings of peat. They are found stratified only in the 25-ft. beach deposits, but some are found far up from the coast-line; and indeed the later are the deposits in which any group of implements is found stratified, the further, as a rule, has it upward extensions from the usual margin of its zone. But the High Drummore group (225 ft.), if it be not divisible into different zones, is a marked exception since it has extensions to a height of about 400 ft. It would have been difficult to explain the zonular distribution, had it not been known that man when he left these relics of his presence must long have dwelt in a climate as inhospitable as that of Iceland, and indeed could only support life here on the shores and that during ameliorations of the intense cold. So gradually have the implements disclosed the secrets of their age, and so startling have some of the results been, that I was

little astonished on examining a celt that was found in a moss at Pinminnoch, Portpatrick, to notice that it afforded what may be an example of glacial scratching in different directions, but chiefly in that of its length. It is of light brown slate stone, has a cutting face at both ends, but not cross-set, like those on an unpolished short thick flint one kindly given me by Mrs M'Gaw, and which was found on Kildonnan Hill, where sand beds were lately exposed. The Pinminnoch specimen is over ten inches long, three and a quarter broad, and one and a quarter thick in the middle. The sides slope out with a slight curvature from the narrow end one and three-fourth inches wide to the rounded face three inches broad. There is more chipping into form than polishing seen, or the once polished surface has been much injured as well as scratched and grooved, or, in other words, the celt has come to grief in ice probably of the close of the surface drift age, and there have been polished implements then. It is a solitary example to draw such a conclusion from; but so was the first flint saw I found in the face of the 70-ft. terrace, and from that day to this my belief that man was closely associated here with glacial conditions has been strengthened more and more, and in spite of strong opposition to it has never wavered. I have got several wrought flints with glacial striæ. It would now be less surprising to find a polished celt *in situ* beneath the surface drift margin than to have found implements of the Curghie group there, and they are there. But still one would expect to get it in more recent deposits than these.

At the time I first found implements stratified in beds connected with the closing scenes of the ice age, the following notice of the fact was sent to a gentleman who had been the greatest historian of the neolithic implements of Wigtownshire. That was in November 1881. He said it completely took his breath away.

You will remember about our 25-ft. raised beach, parts of which are seen along the coast, and about the escarpment of a terrace of stratified sands and gravels, averaging from 50 to 70 ft. in height, and being highest whe[illegible] s of boulder clay (ancient points).

of the scenery on the Bay of Luce. This terrace slopes gradually upward to near a height of 100 ft., where the Silurian rocks (Permian on the west of Loch Ryan) crop up here and there in abrupt faces, as if eroded by the waves of an ancient sea. From this height down smaller terraces and escarpments can here and there be distinguished. Above the higher beach there are also stratified sands and gravels spread over flattened tracts or exposed in gravel pits dug in the fragmentary escarpments. At the period of the 100-ft. beach broad sandy flats with shingle banks stretched seawards along the bay like those at its north end or at Sandhead now. The fullest exposure of this sandy ancient sea-bottom is in the great escarpment just mentioned, though good sections are also opened up by some of the streams, as at Kilstay. Just as the land was rising from the sea then, so it had been rising before. From the height of 75 ft. upwards for 20 ft. or more the stratified sands and gravels in places contain conglomerates of the Queensberry series, Cairnsmuir granites, and other erratics, from the Luce valley, apparently, among the more local and less rounded greywacke and felstone boulders first seen by me in what had been then or shortly before a strait between Kilstay and Clanyard Bay. At the height of 100 ft., near the Howe, there is a large mass of old shore gravel, part of which is exposed. The tract between New England Bay and Port Nessock, as also that between Loch Ryan and Luce Bay, were then completely under water, and their materials are those of the same terrace. But here is the main point,—man inhabited the land both north and south of the strait between Clanyard and Kilstay at the close of the period when great icebergs were stranding on our shores and glaciers were ceasing to leave their *débris* at the mouths of the local valleys. It is questionable if the straits themselves, like another further south (between the Tarberts), were not partly scoured out by ice, though they were preglacial river channels. At the time of the 100-ft. beach, however, though this was in the recent period (?), and long after the recognised boulder clays had clad the hillsides, the ice age had hardly closed when man was leaving his javelin-heads and hammer-stones on the shores of that time,

for such weapons are really found in the oldest of these old shore shingles. And not only so, an elegant flint saw was extracted from undisturbed beds some 3 ft. deep in the terrace between the Free Church manse and Drummore, where a landslip had produced a fresh exposure. Some worn wrought flints were also taken from the same bed at a depth of 5 or 6 ft. Since that time numerous implements have been found stratified where, then, I would have thought it ridiculous to search for them, in positions even as at Biawn Heugh (height between 175 and 150 ft., and higher still) that yield plain evidence of considerable glacial activity, and these are not at all dubious forms, but display elegant workmanship.

Two observers at least have made pretty extensive collections of implements similar to some of the groups found in Kirkmaiden, but neither was aware of the great age that must be attributed to them. For a knowledge of the researches of one of these I am indebted to the kindness of Mr Macconnochie of the Geological Survey. A description of Mr Smith's observations on the Ayrshire coast between Saltcoats and Troon appears in the *Transactions* of the Geological Society of Glasgow for 10th April 1879. It seems that the implements there are much the same as those on the lower beaches here. They contain a liberal representation of what I have called quarter-spires, twisted, elongated, mesially-ridged arrow-heads, with a transverse section either in the form of an equilateral or isosceles triangle. Similar forms, untwisted, and either blunt or sharp pointed, are found at Kilstay, in beds between 50 and 75 ft. above datum line, and cropping out from below those in which the Low Curghie group of implements is found. But these beds are sloping downwards from the old shore, and are considerably below it, which may account in some measure for the large proportion of such implements found at greater heights near the Mull of Galloway. Mr Smith considers that all the implements found by him have been allowed to drop into the sand from the surface of the ancient soil covering it. The sand itself is underlaid by two fossiliferous beds just as the sand and gravel-beds ... e Bay and Loch

Ryan are by the upper fossiliferous boulder clay (purple), and the blue laminated brick clay seen at Clashmahew and Terally. An equivalent ancient soil and similar blown sands are found likewise, so that there is much in common between the sites of the tools in the two localities. But to me it seems that the worked flints, at least some of them, have a far deeper horizon than Mr Smith ever dreamed of. In a half hour spent in Clashmahew clay-quarry, during a journey to Stranraer, a chipped flint was found in the deeper laminated brick clay among shells of an arctic character, and subsequently others have been obtained from a like bed in Terally brickwork. Moreover, the zonular distribution of the surface exposures of the tools and the positions of implements in stratified deposits seem to indicate that they will yet throw light on a long, long rôle of Glacial Man's progress. Mr Smith says that along the coast for 500 yards inland no worked flints are to be found, and hence he infers that the ancient people who used these flints inhabited the land when it was lower than at present. There, however, he says a very beautiful celt turned up. There are similar phenomena here. Among "the scraping-knives" found Mr Smith mentions "straight-edged," "*lance-shaped*," "*duck-bill-shaped*," "semi-circuloid," "patelloid," "spokeshave-shaped," and "irregular flakes with concave chipped hollows, evidently used for finishing arrow shafts." "*All these knives have been fashioned from one side*. The limpit-shaped ones have been worked all round, the oblique chipping having met at a point at the back. Some of the spokeshave ones are serrated on the edges." This would serve as an excellent description of the later groups found in the Rhins, and especially at Genoch, as well as of some found on the surface from about 50 ft. up to about 100 ft., and in some places much higher, as at the Mull. I had a collection of these, from which the finest specimens, some eighty or ninety, were selected and given to Jas. M'Douall, Esq. of Logan, long ago. What Mr Smith calls drills are also to be obtained here, but, unfortunately, he took a piece of slate and solemnly drilled holes in it with them right and left handed wise. This was like Mark Twain's pauper prince taking the Great Seal of England *to crack nuts*

with! But he evidently had a suspicion of their true nature, for he adds, "If they were ever used as arrow-heads they would set the arrow spinning in the air like a ball shot from a rifle." Precisely what they did, and one of the chief reasons for my considering them later than the untwisted forms, without having stratigraphical evidence. Those of the names of scrapers I have italicised seem also to refer to arrow-heads, but of a more ancient type, and the fashioning from one side to a character of the late glacial implements. Mr Smith's arrow-heads are one with the usual sharp point and straight sides, and with a convex base where it fitted the shaft. (Such have been found here at the Mull, Auchneight, High Slock, and Macherally.) The next had in addition a central prong where it was fastened to the shaft, the third like the second, but with convex sides, and apparently fashioned from broken forms of the second kind. (Forms like these are found sparsely from Creechan Park to the Mull, and also on the 70-ft. terrace inland from Luce Bay.) The arrow-heads of the fourth type were all leaf heads, one being made of quartzite. Here in different localities a few of these have been got on the surface.

The other observer of flint implements referred to was the Rev. Mr Wilson of Glenluce, who has done very much to elucidate all sorts of antiquities in Wigtownshire. A summary of his work on flint implements, with many fine illustrations, is to be found in the last published volume of the *Transactions* of the Society of Antiquaries for Scotland (first article). According to his own account there, p. 4,—"The Glenluce flints are chiefly found on or near certain old sea-beaches at the head of the Bay of Luce. These are about 20 ft. above sea-level, and run from N.E. to S.W. in parallel storm-beaches" (meaning raised beaches, or perhaps ridges of sand-dunes) "from a point near Park Hay in Glenluce to a point near Sandhead in Stoneykirk, a distance of about six miles." I have found implements not only on the 25-ft. beach, though here is the great site of the neolithic ones such as are described by Mr Wilson, but also on the much higher upraised sea-bottom that skirts our coast, and even in zonular distribution round the higher old shores, and now also strati-

fied up to nearly 350 ft. in height. I have not seen sufficient undoubtedly neolithic relics—perhaps a dozen polished celts and some four or five barbed "elf-shots"—to know much of the later stone-age men's choice of a dwelling-place. Yet they seem to have occupied the head of the 25-ft. beach, and have perhaps come hither before the close of the surface drift period, or rather in its last closing scenes, and may have seen the land rise to 75 ft. above its present elevation, and also have risen with the old sea to the 25-ft. beach, where they have left numerous interesting remains. Other relics of them are found in peat-filled hollows like the Black Moss. They may also have been crannoge dwellers in lakes long emptied by denudation of some parts of the margins, or drained like Dowalton Loch for agricultural purposes. Here again Mr Wilson has been doing good scientific work. Lately some of the old implements have been found by me on the west coast near the Mull, as well as at Auchneight, Knockencule, Barncorkrie, High and Low Clanyard, Cowan, Port-Logan, Mullhill, Ardwell Bay (Stoneykirk), Port o' Spittal, and the shores of Loch Ryan; but they are much more thickly distributed along Luce Bay and in the hollows stretching between the two shores. In many of the implements which Mr Wilson according to prevailing custom designates scrapers and saws, I see very elegantly-finished arrow-heads of a more ancient type by far than the barbed and stalked ones of Neolithic Man. The great distinguishing feature of the late glacial arrow-heads, here at least, is their generally flattish under surface, with less or more chipping away from a longitudinal ridge above, or with the ridge unchipped or completely flaked off, but, above all, their elongated lanceolate form. Variations among them are marked by approaches to the leaf pattern in the more modern ones, or by lateral barbing, or widening or narrowing, or curvation either in or away from a horizontal plane. The transition was from these to leaf arrow-heads, then to winging at the base, and latterly to a footstalk as well as barbs, these last being assuredly neolithic.

It has so long been asserted firmly that there are no pre-neolithic implements in Scotland, and that their great site

is in the South of England and North of France—that it is no easy matter to convince scientific men of their presence. Even up till now the Rev. Mr Wilson, an enthusiastic investigator, has not found any implements stratified. I have shown them to many persons bedded deep in stratified gravels in almost inaccessible localities on the heughs from 50 to 350 ft. up, and wish Mr Wilson would search carefully for them, for the conversion of such a good man and true would soon lead to the general acceptation of the fact. The beds, in or on which they have been found on the coast of Ayrshire and here, have once—namely, in preglacial times—been the old gravel terraces of the river Kelvin (when it swept round Corsewall) and of the Clyde, which passed through Loch Ryan to Luce Bay. Later they were redistributed into estuarine, and later still in late glacial times into marine, beds. They bear much resemblance to the valley gravels of the South of England and the Somme Valley—but after their redistribution the lower members were clad with a till as the Hessle gravels were in the North-West of England. It is, however, questionable if any of the implements in the old shore gravels and tills mentioned above date back beyond the last eighth of the ice age.

XXXIII. *Note on the Great Variety of Colour in the Eggs of the Black-headed Gull* (Larus ridibundus, L.). By JOHN ALEX. SMITH, Esq., M.D. [Specimens exhibited.]

(Read 21st February 1883).

Naturalists are all aware that though the colouring of the eggs of different birds generally show a great similarity in the general body colour of the shell, and also of the various colours and arrangement of the spots over the shell, still there is not anything like an absolute uniformity, as indeed might be expected, as well from the varying age of the birds themselves, as also from the state of health of the individual bird. Some species of birds appear, however, to show a greater range of colour in their eggs—both of the body colour of the shell and also of the colours and arrangements of the spots which may more or less cover its surface.

The Black-headed Gull is a species which has a great variety of colour in its eggs, as the specimens now exhibited show — so much so, indeed, that an ordinary observer would scarcely believe it possible that all these eggs, varying at once in size and colour, belonged to the same species of bird. I am indebted to the Rev. J. M. Joass, minister of Golspie, Sutherland, for being able to exhibit this very curious collection of eggs. From the bird nesting in great numbers together, often in some island in an inland loch, it is, of course, comparatively easy for the collector to go among the number of nests and make selections of the varieties of those eggs season after season. In a note to the writer, Dr Joass states that the eggs were obtained from an island in Loch Salachaidh, parish of Golspie, Sutherland, 5 miles inland, and about 550 feet above sea-level. "The only birds observed on the island," he states, "were the Black-headed Gull and Common Gull in about equal numbers. Some wild geese and teal were seen on the loch. A widgeon's nest with eggs hard set was found in long heather near the loch on May 15th, 1882."

The general colour of the eggs of this bird is an olivaceous green, differing in intensity, with brownish and purplish spots. The four eggs now shown illustrate the more ordinary colours, but these, it will be seen, show a very grèat range from a dark olive colour, covered with brown and purplish spots, to a very light greenish colour, with spots and blotches of dark brown intermixed with lighter purplish blotches, one egg being almost white, with a few very faint spots of purple scattered over it. These eggs have the spots and blotches scattered pretty generally over their surfaces; there is one, however, which shows a somewhat similar but duller greenish body colour, but which has the greater number of the spots collected into a sort of blurred ring round the larger extremity of the egg.

The four eggs now exhibited show no greenish colour at all, but a general reddish tone, one being covered with bright reddish brown and fainter purplish spots; the others showing a general less strongly defined spotted character, the spots diminishing both in size and intensity of colour. Two of the

latter were found near each other, probably from the same nest, in May 1881. The strongest marked egg, and the faintest coloured one, were taken in May 1882, and were also stated to be near each other. We almost infer, therefore, that these four eggs were produced in these two years by the same bird, as they were found each year at the same side of the small island.

I shall not attempt to enter here into the causes of this more or less variety of the coloration of the eggs of birds, but shall merely say that it is, in all probability, due to changes in the secretion of the colour glands in the oviduct of the bird, due, it is believed, to changes in the health, and the rapidity of oviproduction, as well as in the age of the bird.

XXXIV. *On a hitherto Unrecorded Specimen of the Great Auk* (Alca impennis, *L.*) *in the Collection of His Grace the Duke of Roxburghe.* By JOHN GIBSON, Esq. [Specimen exhibited.]

(Read 18th April 1883.)

The writer, after giving a sketch of the history of the Great Auk, continued as follows :—There is, at least, one man still alive—a St Kildian—who has seen a living specimen of this bird in Scottish waters. It is somewhat surprising, therefore, that with the bird so lately alive at our doors its remains, whether in public or private collections, should be so rare in Scotland. In the most recently published list of the known remains of the Great Auk—that of Professor Newton in the *Ibis*—the number of recorded skins is placed at 71 or 72 ; of skeletons, 9 ; of detached bones of different birds, 38 or 41 ; and of eggs, 65. To the list of eggs must be added the two recently found in an Edinburgh collection, and now in the possession of Lord Lilford; also the large quantity of detached bones brought from Funk Island in 1874 by Mr John Milne. Of all the specimens recorded in the *Ibis* list only two are in Scotland—namely, a pair of eggs in the Edinburgh Museum of Science and Art. Since the appearance of Professor Newton's list, the Museum of the Society of Scottish Anti-

THE GREAT AUK (*Alca impennis*, L.).

From a Photograph of the Specimen belonging to His Grace the Duke of Roxburghe.

quaries has acquired several bones of the Great Auk from the kitchen-middens of Caithness. The Edinburgh Museum of Science and Art has also obtained a considerable part of the skeleton of a Great Auk, purchased from a dealer, and probably forming part of the above-mentioned Funk Island remains, besides a small collection of Auk bones recently found by Mr Symington Grieve, when excavating an ancient mound in the island of Oronsay. From the same mound a few additional bones have been got by Mr Wm. Galloway. These are now in the possession of Sir John M'Neill, proprietor of the island. Kitchen-middens along the west coast of Scotland have as yet been but little examined; it is not improbable, therefore, that further explorations of the kind made by Messrs Grieve and Galloway in Oronsay may prove the Great Auk to have been more than an occasional visitor to the Scottish shores.

Of the 71 or 72 recorded skins of the Great Auk, the United Kingdom possesses 22, not one of which, however, are to be found in any Scottish collection. It was with much pleasure, therefore, that I learned some time ago that Mr Brotherston, the well-known naturalist of Kelso, had discovered a stuffed specimen of the Great Auk in the collection of birds belonging to His Grace the Duke of Roxburghe at Floors Castle. On his suggestion I communicated with the Duke as to the desirability of putting on record the existence of this hitherto unnoticed specimen, and His Grace at once agreed to the bird being exhibited at the Royal Physical Society. Unfortunately the history of this particular specimen is entirely unknown. On the under side of the stand the words "Great Auk—male" are written, but neither locality nor date is given. The collection of birds at Floors Castle, I am informed by Mr Brotherston, was made by the late Duke sometime between 1830 and 1840. This, however, was the period during which the Garefowl was being systematically done to death on the skerry, off Iceland. It is probable, therefore, that in the specimen now exhibited we have one of the 60 birds taken from that last refuge of the Auks between the years 1831 and 1844, and which are known

to have been dispersed among public and private collections throughout Europe.

The bird is an adult male in full summer plumage; the following being its principal dimensions:—

Length from tip of bill to end of tail,	$34\frac{1}{2}$	inches.
„ of tail, . . .	3	„
„ of tarsus, . . .	$2\frac{1}{2}$	„
„ of wing, . . .	$6\frac{5}{8}$	„
„ of bill dorsally, . .	$3\frac{7}{8}$	„
„ of gape, . . .	$4\frac{1}{2}$	„
„ of bill from nostrils, .	$2\frac{3}{4}$	„
Depth of bill, . . .	$1\frac{3}{4}$	„

There are 7 ridges on the upper, and 11 (two of them indistinct) on the lower mandible. The number of ridges and the large size of the bird point to the specimen as being that of an old male. In conclusion, I beg to thank His Grace the Duke of Roxburghe for allowing this interesting, and, so far as Scotland is concerned, unique specimen to be exhibited at the Royal Physical Society, and to be recorded in its Proceedings; and also Mr Brotherston for assistance rendered in preparing this notice.

XXXV. *Water Supply of Villages.* By JOHN HUNTER, Esq., F.C.S.

(Read 18th April 1883.)

Than the water supply of a village, or of any other inhabited place, nothing can be more important. The advisability—or I might almost say necessity—of bringing these notes before this Society to-night, has been suggested to me from my having for many years past—but perhaps more forcibly recently than ever before—had many opportunities of judging of the almost universally dangerous condition of rural water supplies.

The sources from which these supplies are most commonly drawn are burns, rivers, *so-called* springs, and wells.

The first of these—*i.e.*, burns and rivers—I had occasion recently to refer to in an essay which I wrote, and from

which I may advantageously now quote, in order to show to what dangers water drinkers are exposed. This essay, which had for its title "Pollution of Rivers," gives in detail the different kinds of pollution to which our rivers are liable, and also the various methods adopted or suggested for the prevention of pollution. It is beyond the scope of these notes to refer to this essay upon any other point than that which treats of the impurities introduced at the higher levels, because it is rare that a burn or river that has run any very great distance is employed for primary purposes. After pointing out the disgusting practices of farmers, in disposing of their cases of splenic apoplexy, louping ill, sturdy, etc., I go on to remark:

". . . In like manner hill farmers contribute not a little to the pollution of streams, by exercising all the carelessness their ingenuity is capable of during the seasons of 'dipping' and of 'washing.' It is only a few years ago that evidence was led in the Court of Session, which proved that, as the result of 'dipping' and subsequent washing of sheep in feeders of Loch Rutton, the presence of the poisonous metal arsenic was easily demonstrable. The polluters were, of course, very indignant, and, among other pleas, advanced that of prescriptive right!—a prescriptive right to pour annually many pounds weight of arsenic into the internal economy of the unsuspecting inhabitants of Dumfries!!

"Such conduct is without excuse, the more so when we know that for 'dipping' purposes an insoluble compound of arsenic is used, which could most certainly be prevented finding its way into the feeders of the loch by an easily devisable system of filtration. No doubt the process would involve a little trouble, but that is all.

"Perhaps the most to be dreaded of all pollutions is that from fever-stricken inhabitants of the high lands. It is well known now that fever germs are, like many other of the lower organisms, most persistent; we know also, how awful are the results of carelessness at the period of desquamation; yet we are only too well aware of the utter disregard for other people practised by the class of individuals referred to. Bed and body clothes are washed, and the washings trickle

nearest stream, if, indeed, they are not washed in the .n itself; the excreta from the fever patient is, by his attendants, hurriedly popped into the burn, in order that it may be away from themselves; while all the time the next n down the stream is drinking this lively beverage, or it be he is bulking with it the milk which he supplies to some neighbouring city, and thus is pouring into our midst may be the seeds of an epidemic that may hurl pre-urely into eternity hundreds of his fellow-beings.

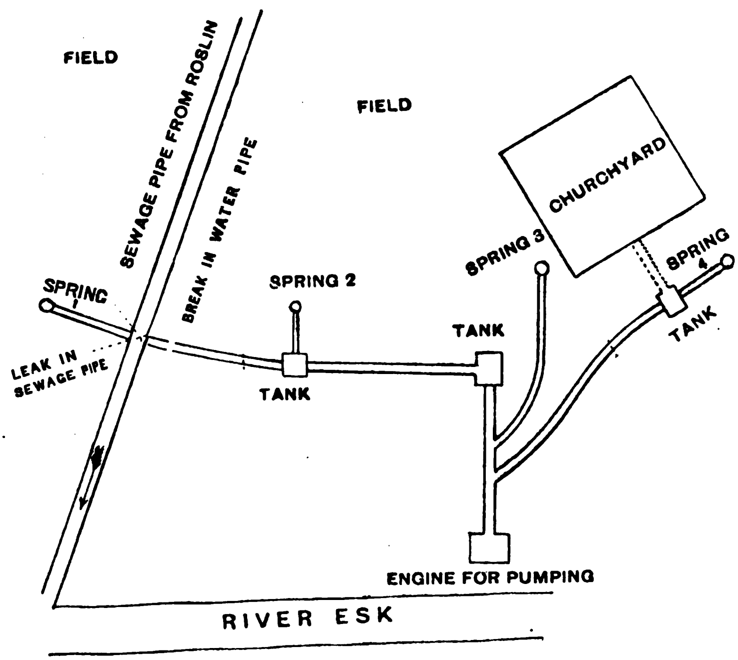
"For the best method of dealing with such cases as these, it is only necessary to refer to the very clear 'instructions' drawn up by Dr Littlejohn, medical officer of health for Edinburgh, and it would be well for all concerned if these or other equally efficacious means of dealing with fever patients—were made compulsory throughout the country. Like the work of most other public benefactors, these 'instructions' of Dr Littlejohn's were branded as 'useless,' 'absurd,' 'unworkable,' etc.; but notwithstanding that, there is every evidence already that they were perfectly necessary, and it is not saying more than is true when we make the statement, that, but for the foresight of the Edinburgh medical officer of health, that city would in all probability be now the centre of a typhoid epidemic. . . ."

Much more could be said in regard to burn and river pollution, but for the present perhaps there is sufficient.

The next sources of water supply to which I would refer are springs *so-called*, and wells.

What are these springs? For the most part they are simply water finding its way from a higher to a lower level, licking up in its travels all kinds of decomposing or decomposable animal and vegetable matter; and just in proportion to the distance it runs, and the impurities it meets with in its course, will be the extent of pollution. No doubt these spring waters pass through considerable depths of soil, which it may be claimed will act as a filter, and purify the water. No doubt it does so, in so far as removing insoluble or suspended matter is concerned, but it must be remembered that by far the most dangerous impurities are those which are in solution, and these are but little likely to be affected

in passing through a soil which is probably surcharged with matter deposited by or filtered from the water itself; indeed it is quite well known that a filter of this description requires both cleaning and renewing, otherwise it soon becomes a polluting rather than a purifying medium. It cannot be denied that there are many springs of wholesome water, but there are also very many which, though once of that character, cannot now be regarded as else than outcroppings of sewers. Springs in the neighbourhood of villages with an increasing population must necessarily become sources of danger. Primitive sewers, or other ways of getting rid of animal excreta, will multiply; high manuring of adjoining fields will follow; and the drainage water from these may indeed be the sparkling spring itself. There is yet another element of danger, and I may best explain it to the Society by putting on the board a few chalk lines. [Mr Hunter here referred to the case of Roslin, where at the moment typhoid fever was raging, the outbreak being clearly traceable to an impure water supply. The following is the diagram he drew:]



With reference to wells, these are generally sunk as near to the houses as is convenient, but rarely beyond the drainage area of the byre, the stable, the piggery, and the privy. As a rule, all seems fair on the surface; but deep and out of sight there is a cavity, the receptacle of the decomposed and filtered essence of every living thing above.

The question may naturally suggest itself, Why, if things are so dreadfully bad, is there not more disease and death? *Primo loco*, Inhabitants of small villages and roadside places, where wells are most common, are as a rule living in pure air, and are consuming plain, wholesome food, and thus are therefore presumably existing under circumstances better calculated to withstand the effects of impure water; or, *secundo loco*, We may have to refer to the investigations of Koch, Pasteur, Tyndall, or others who have been working in the same field. It is possible that people living under such conditions as I have indicated have partaken of putrefactive *microbes*, and have thus been innoculated by attenuated forms of these; and to me this seems a not unnatural conclusion to come to, knowing as I do of many instances of diptheric sore throats and other abnormal conditions which have prevailed in districts where I have ascertained the unmistakable badness of the water supply.

If we study but for a little the recent works of the authorities I have just named, it will not be difficult to understand how it is that summer visitors from cities going to country places, not unfrequently keep ailing during their rustication, and return to their town homes to be laid low with typhoid or dyptheric symptoms, if indeed they are not made subjects long ere that time has arrived.

There seems but one remedy for the undoubtedly at present existing state of matters, and it is not far to seek. To every district there should be appointed a thoroughly qualified medical officer of health, whose duty it shall be to inquire into the water supply of every house, either by himself chemically and microscopically examining the water, or by submitting it to the public analyst of his district. . . .

XXXVI. *On the Occurrence of Pterygotus and a Limuloid in the Caithness Flagstones, and on the Nature and Mode of Formation of "Adam's Plates."* By B. N. PEACH, Esq., A.R.S.M., of the Geological Survey of Scotland. [Plate VII.]

(Read 17th January 1883.)

Between the years 1860 and 1867, C. W. Peach obtained from Sarclet, in the neighbourhood of Lybster, on the east coast of Caithness, a fragment of a Eurypterid exhibiting a similar sculpturing to that of Pterygotus. The beds from which the specimen was derived are supposed to be the same as those which underlie the Caithness Flagstones at the "Ord," and which, after disappearing under the latter near Berridale, here rise from beneath them in the form of a low arch. These rocks Sir Roderick Murchison classed with his Lower Old Red Sandstone, while he looked upon the Caithness Flagstones as forming his Middle division. He therefore attached much importance to the finding of Pterygotus among these Sarclet rocks, as he considered that it confirmed his opinion that these low beds were the equivalents of the Forfarshire flags, thus proving that they were of Lower Old Red Age.

In his account of the discovery published in the fourth edition of "Siluria," * however, he makes a singular mistake, for he says, "Since the last edition of this work an important confirmation of my view respecting these lower sandstones being the equivalents of the Arbroath beds or the Lower Old Red of Scotland has been made by Mr Charles Peach. That successful fossilist detected in strata near Lybster, much older than the Caithness flags, the remains of a portion of Pteraspis—an ichthyolite never yet found above the lowest of the three divisions of the Old Red Sandstone." †

To show how little dependence can be put on such negative

* Pp. 257, 258.

† In writing the above passage Sir Roderick Murchison must have been trusting entirely to memory, and writing without notes, as he confounds Pterygotus with Pteraspis. There can be no doubt that, at one time, at least, he was aware of the nature of the fossil which C. W. Peach handed over to him. and which had been studied by Salter, and pronounced to be a

evidence as the not finding of a fossil form in determining the relative age of a series, I am enabled by the kindness and courtesy of our President, Dr Traquair, to demonstrate that the remains of Pterygoti as colossal as those from the Arbroath beds occur high up among the Caithness flags. The same evidence therefore would rob Sir Roderick of his Middle Old Red Sandstone as far as Caithness is concerned. On other and more satisfactory evidence Dr Archibald Geikie has shown that there is really no means of separating the two groups in Caithness, both of which he classes with the lowest division of the Old Red.* He further shows that there is every reason to believe that the Caithness beds were in the main the equivalents of those of Forfarshire, though they were accumulated in an area which was cut off from the more southern one by the barrier of old rocks of the Grampians,—in fact that the Lower Old Red Sandstone in Scotland was a lacustrine formation, and that the two sets of strata were in all probability deposited almost simultaneously in different lake basins.

In 1858 a fragment of what appeared to be an animal allied to Pterygotus was exhibited at the British Association Meeting at Aberdeen, which had been found in the island of South Ronaldshay. The rocks in this island are the continuation of the highest beds of the Caithness Flagstones.†

A short time ago Dr Traquair drew my attention to some Eurypterid remains among a lot of fossils collected from the Caithness Flagstones in the neighbourhood of Thurso by the late John Miller, and acquired from his heirs for the Museum of Science and Art, Edinburgh. Some of the specimens bear the date 1859.

Among the fragments collected by John Miller there is at least one specimen allowing of description, and of being named, and which appears to be new. It also throws light on the structure of Pterygotus, while others illustrate the mode of formation of some curious circular quoit-like impres-

* "Old Red Sandstone of Western Europe" (Trans. Roy. Soc., Edinb., xxviii., pp. 345-452).

† Mr C. W. Peach informs me that this specimen is dep[osited in the] British Museum.

sions which are locally known in Caithness as "Adam's Plates," and which are evidently formed from the posterior segments of Pterygotus like animals vertically compressed.

Pterygotus Dicki, Nov. Spec.—Pl. VII., Fig. 1.

The specimen, for which the name is proposed after the late Robert Dick, who did so much towards bringing to light the denizens of the Lower Old Red flags of Caithness, and from whom in all likelihood John Miller acquired some of his specimens, being a closed ring is one of the last body segments of a large individual. It is quite detached, and no other fragment is found on the same slab with it, though that is a large one. The segment is nearly circular, and measures 5 inches across. From the manner in which it is preserved its depth cannot be made out, though it must have exceeded 3 inches. It is fossilised, end on, with the anterior articulation downwards, and thus entirely hidden in the matrix. Its posterior margin, however, is well exhibited, and as this bears a strongly denticulated fringe which is more pronounced on the dorsal than on the ventral aspect, it thus differs from all as yet described species of Pterygotus. The elongated squames forming the posterior marginal fringe are longest in the mid line of the back. Such a fringe is found on species of the genera Eurypterus and Stylonurus, but as in addition to this the segment bears a raised keel of large squames along the mid line of its dorsum, which losing itself anteriorly is carried back through the hinder half of the segment to its margin, it shows that its owner's affinities are with Pterygotus and with a species allied to the *P. Anglicus*. This keel, and the fact that the segment is a closed ring, show that we have to deal with one of the last five segments, and in all probability with the antepenultimate segment, *i.e.*, the eleventh abdominal one, or the seventeenth segment, if we consider the cephalothorax as made up of six coalesced segments as in Limulus and scorpion. There seem to have been no lateral crests, and the segment is not depressed, but as already stated, it is almost circular. The test is everywhere ith the characteristic scale-like markings, which han on the corresponding segment of

P. Anglicus, which is also different from the former in having the sculpturing confined to its anterior half only. The squames on *P. Dicki* become more acute as they approach the posterior margin, and are more highly embossed on the dorsal than on the ventral aspect, though on the latter they are somewhat the larger. The fringe above alluded to is composed of these embossed squames, only they are enormously produced when compared with those on any other part of the segment except on the dorsal keel (Pl. VII., Fig. 16). The individual squames of the fringe are smooth above, but beneath they bear numerous other elongated small squames (Pl. VII., Fig. 1*a*). From the fringe the test is rapidly inverted, and passes obliquely inwards and forwards, forming a hollow inverted cone which is abruptly truncated. This conical flange is also highly ornamented with a particular acutely lobed, small, squamiform pattern, the convexities of the scales pointing backwards, clearly showing that this is not an accidentally folded-in portion of the external test. The ornament ceases at a distance of from half to three-quarters of an inch, when the flange becomes smooth so as to form the posterior articular surface, and the truncated edge ends in a corrugated skin-like membrane, portions of which have been preserved, and which doubtless once formed the connection with the anterior articulation of the following segment. From the above circumstances the segments of this part of the body must necessarily have been much narrower in front than behind, and in all likelihood they bulged considerably towards the middle as in the allied *Slimonia acuminata* (Fig. 1*c*).

The knowledge obtained from the study of the above specimen is of material help in explaining the formation of the so-called "Adam's Plates." These have been produced by corresponding segments to that described of various Pterygoti, but which show no characteristics by which they can be relegated to any particular species. The relation of the specimen above described to the matrix in which it is embedded, throws a good deal of light on the manner in which it became entombed and fossilised. As already stated, the segment, being one of the last five, is a broad closed ring,

with the anterior portion the narrower. On the decomposition of the animal to which it belonged, the disjointed rings seem to have been swept away by some current. On coming to rest this particular one must have settled with its anterior end downwards. This fact is proved by the rain pits on two successive layers of the flag in which it is embedded. The segment is also tilted over on one side as if by the current, which, though no longer able to bear it forwards, yet, after its lower part became embedded, helped to bend it as it gradually became sodden, decomposed, and weakened. It eventually became filled up inside, and covered up by the accumulating sediment till it had been buried to a considerable depth. The material which forms the Caithness flags is highly flaky, and it is to this that they owe their fissile character. This sediment, then, must have fallen very lightly, and become prone to be much reduced in bulk when subjected to vertical pressure. The growing weight of sediment had gradually compressed the layers among which our fossil is embedded while they were still in a soft uncompacted state, for the two vertical sides of the ring are highly corrugated, while the sloping sides are much less folded; the angle at which it has lain with the horizon must therefore have been considerably diminished by the pressure (see diagrams Pl. VII., Figs. 2 and 2*a*).

"Adam's Plates" are produced when a closed segment has been embedded in a vertical position, and then compressed. In the case of one of the most perfect specimens in the collection, which measures seven inches across, the particulars of its formation seem to be this. As in the former instance the disjointed tail ring has been borne along, and come to rest with its anterior end downwards, to which fact the rain drops on the flags are the witnesses. Though the ring was undoubtedly very strong and chitinous at first, yet the process of filling up and embedding seems to have been so protracted, that the test had become weakened and bulged out, and the inside flange of the posterior articular surface had been somewhat flattened by coming to rest on the material inside the ring. After being eventually embedded, the pressure of the superincumbent *débris* had accentuated

the bulging, and had corrugated the sides where they approach the vertical. The flag, in being split open, has given way along one bedding plane till the body ring is reached at its vertical part. The line of the interior of the ring is then followed backwards till the inner or truncated edge of the flange is reached, whence the flag has split along another bedding plane at a little higher level than the first. The upper half is the only part of the specimen which has been retained, and when this is turned upside down a circular depression, like that made by a quoit being pressed into some plastic material, is observable (Pl. VII., Fig. 3-3*d*). The animal to which the above segment belonged could readily have been a specimen of *P. Anglicus.* If so, the segment must have been about the fourth or fifth from the telson, as it bears no dorsal nor lateral keels. It is comparable to one of that animal as to size, and in another respect it is like it in having no ornament on the hinder portion of the segment. A few squame-like embossings are observable where the sides of the plate become vertical, but they are much obscured by the puckering alluded to.

There are several modifications of "Adam's Plates." One ring has given way before being subjected to pressure, and has been rent by several vertical tears. The fossil now looks like the rim of a bottomless plate which has been broken up into several portions by the dividing cracks which radiate from what appears the centre of the would-be plate. Occasionally a tail ring has split at one place only, and partially opened out, but has still retained sufficient curve to cause it to pass up through several layers of sediment, and so to become corrugated during the compression.

With the exception of one piece, which appears to be the portion of an Endognath from which the toothed margin has been broken off, every portion of Pterygotus in the collection appears to belong to the hinder segments. It may be that these rings were more conspicuous, and that they caught the eye of the quarrymen who may have therefore preserved them in preference to other portions; or, what is quite as probable, the remains had been water-borne for a considerable distance before being embedded. With the exception of the

chelate palpi these tail segments are the strongest parts of the animal's test, and therefore the most apt to resist decay. The tail was highly muscular, containing few of the viscera except the straight intestine, so that the test of that part required a great deal of stability. This was obtained by the bulging and arching of each segment, by the internal flange, the dorsal keel, and embossing of the test.

The Limuloid referred to in the title of this paper is the cast of a Limulus-like creature which was got by C. W. Peach from the Caithness flags, near John o' Groat's House, where the highest beds of the Lower Old Red Sandstone which are to be found in Caithness occur. Though merely a cast, and altogether not over an inch and a half in length, and not quite so broad, it is sufficient to show the impression of a large carapace, which has been divided into several raised and depressed areas paralleled on each side of a mesial line, though now somewhat distorted by pressure. This is flanked laterally by the usual recurved horns at the posterior angles. Behind the carapace are the impressions of seven body segments, each of which has a central lobe and pointed epimera, ending in recurved spines. At the place where the tail spine occurs in Limulus and Bellinurus there is a depression in the matrix such as could be produced by a similar one. From the manner in which the central lobed portion of the abdomen is deeply impressed, there is every reason to believe that the segments were movable on each other, and not coalesced into an abdominal shield as in Limulus. The affinities therefore of the creature are more with Bellinurus than any other known Limuloid, though the specimen is too hazy to assign even a generic name to. The accompanying outline sketch shows the parts that have been made out after a lengthened study, which leaves no doubt of the specimen being the cast of a Limuloid (see Pl. VII., Fig. 4).

The specimens of Pterygotus and the Limuloid cast have been described mainly to draw the attention of geologists to the fact that the remains of such creatures do occur in the Caithness and Orkney rocks, so that collectors may be induced to look particularly for them, as there is a peculiar interest attaching to the history of this group of animals.

It would be specially interesting to know what forms lived between the Neolimulus of Upper Silurian and the Prestwitchia and Bellinurus of Carboniferous times.

Explanation of Plate.

Fig. 1. *Pterygotus Dicki*, n. spec. Antepenultimate segment, reduced 3 diameters, showing exterior of ventral surface, the dorsal surface, partly as a cast, and portion of its interior, also portion of posterior flange. Fig. 1*a*. Portion of the under surface of flange and marginal fringe, to show nature of ornamentation,—natural size. Fig. 1*b*. Portion of upper surface of marginal fringe,—natural size; from Lower Old Red Sandstone, Thurso, Caithness; now in the collection of the Museum of Science and Art, Edinburgh. Fig. 1*c*. Diagrammatic restoration of the antepenultimate segment of *Pterygotus Dicki*.

Fig. 2. Diagram to show the manner in which the angle of the sloping sides of Fig. 1 has been lessened by compression of the matrix. The dotted lines show the position before, and the firm lines the position after, compression. Fig. 2*a*. Diagram showing the manner of compression of the vertical sides of the same ring. The dotted and firm lines bear the same relation to each other as in Fig. 2.

Fig. 3. Diagram to show the formation of "Adam's Plate" from tail ring of Pterygotus. *a*, Dotted lines, showing ring before compression; *b*, firm lines, ring after compression; *c*, section of flag, with that portion of ring concerned in the formation of an "Adam's Plate," in its natural position. Fig. 3*d*. Section of above flagstone turned upside down.

Fig. 4. Outline of cast of Limuloid allied to Bellinurus; from the Lower Old Red Sandstone, near John o' Groat's House, Caithness. From C. W. Peach's Collection.

JOURNAL OF PROCEEDINGS.

SESSION CXI.

Wednesday, 16*th November* 1881.—Mr ROBERT ETHERIDGE, Jun., F.G.S., President, in the Chair.

The following gentlemen were elected as Ordinary Fellows of the Society: James Lumsden; Archibald Craig, Jun.

An Opening Address was delivered by Mr ETHERIDGE, the retiring President, on "The Palæozoic Conchology of Scotland."

Wednesday, 21*st December* 1881.—Professor A. GEIKIE, F.R.S., President, in the Chair.

The following Office-Bearers were elected:

Presidents—Professor A. GEIKIE, F.R.S.; Professor H. ALLEYNE NICHOLSON, F.R.S.E.; R. H. TRAQUAIR, M.D., F.R.S.

Secretary—ROBERT GRAY, F.R.S.E. *Assistant-Secretary*—JOHN GIBSON.

Treasurer—CHARLES PRENTICE, C.A. *Hon. Librarian*—J. T. GRAY, M.A.

Councillors—A. Galletly; George Leslie, M.B., C.M.; A. B. Herbert; John Sadler; B. N. Peach; D. J. Surenne; John Walcot; Professor Duns; T. B. Sprague, M.A.; William Evans; Andrew Wilson; A. C. Stark.

The following gentlemen were elected Ordinary Fellows of the Society: William Berry; Reginald Ernest Horsley; T. Slingsby Tanner; James Maclaren; A. N. M'Alpine.

The following communications were read:

1. "On the Zoology of Middle Lochaber." By Professor J. DUNS. Professor DUNS also exhibited a nest and eggs of the Eider Duck (*Somateria mollissima*) from the Isle of May, Firth of Forth.
2. "On Hysgeir, off Canna, and its Bird Life; with Notice of the Breeding of the Pintail Duck (*Anas acuta*)." By J. A. HARVIE-BROWN, F.Z.S.
3. "Notes on the Entomology of the New Forest;" with exhibition of Specimens. By WILLIAM EVANS.

Wednesday, 18*th January* 1882.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Rev. Charles Rogers, LL.D.; James Simpson; Walter John Haldane Cumming; Samuel Crockett; David Taylor; Robert Stewart; Andrew Hogg; W. R. Macdonald.

The following communications were read:

1. The SECRETARY exhibited two specimens of Reeves' Pheasant (*Phasianus*

Reevesii), which had been shot in October last by Lord Balfour of Burleigh, on the estate of Elvedon, in Suffolk; and read a communication from Lord Balfour on the occurrence of the bird in a wild or comparatively wild state in various British localities, but principally in Scotland.

2. "On some Fossil Myriapods from the Lower Old Red Sandstone of Forfarshire." By B. N. PEACH, F.G.S., etc.
3. "An Addition to the Fish Fauna of the Oil Shales of Edinburghshire." By JOHN GIBSON.
4. "On the Gnawing of Water and Gas Pipes by Rats and Mice." By ALEXANDER GALLETLY.
5. "Additional Notes on the Algæ of the Firth of Forth;" with exhibition of Species new to the Forth and to Britain. By GEORGE WILLIAM TRAILL. (Communicated by Professor Duns.)
6. Dr TRAQUAIR drew the attention of the meeting to an interesting Hybrid between the Pheasant and the Black Grouse, which had been sent for exhibition by Mr Small, George Street. The bird, which was obviously the offspring of a male pheasant and a grey hen, was shot on 28th December last on the estate of Glenapp, near Ballantrae, Ayrshire. It had the bill of a pheasant; the erectile tufts and the papillar patch round the eyes partially developed; the front of the *tarsi* feathered downwards about an inch from the joint; the iris of a dark hazel; the bend of the wing with a white shoulder patch; and the plumage of the neck and breast highly glossed, and suffused with a strong purplish lustre.

Wednesday, 15th February 1882.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Captain R. G. Wardlaw-Ramsay; Rev. W. Deans Cowan; J. Young; T. Alfred Hird.

The following communications were read:

1. "Report on Specimens of Tail-less Trout from Kirkcudbrightshire." By Dr TRAQUAIR, F.R.S.
2. "A Preliminary List of the Scottish *Myriapoda.*" By T. D. GIBSON CARMICHAEL.
3. "On the Occurrence of the Tree Sparrow (*Passer montana*) in Argyleshire; with Notes on the Distribution of the Species in Scotland." By JOHN J. DALGLEISH.
4. Mr A. C. STARK exhibited (1.) Nests and Eggs of the Shoveller Duck (*Spatula clypeata*) and Scaup Duck (*Fuligula marila*), both from Fifeshire; (2.) Nest and Eggs of Goosander (*Mergus merganser*), from Sutherlandshire; (3.) Nests and Eggs of various American Birds.
5. Mr DALGLEISH exhibited, with remarks, the gg of Audouin's Gull (*Larus Audouini*).
6. "Note on the Breeding of the Sandwich Tern (*Sterna Boysii*) and Lesser Tern (*Sterna minuta*) on Inch Mickery, Firth of Forth." By WILLIAM EVANS.

Wednesday, 15*th March* 1882.—Professor A. GEIKIE, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Harry Armour; Colin Alexander M'Vean; James L. Grant Wilson; John Swinburne; John Ferguson; James Stirling; Herbert E. Rawson; L. M'Kinnon M'Donald.

The following communications were read:

1. "Note on a Remarkable Skull of Babyrussa (*Babyrussa alfurus*, Lesson)." By R. H. TRAQUAIR, M.D.
2. "The History of the Chough (*Fregilus graculus*) in Scotland." By J. HAMILTON BUCHANAN.
3. "Note on the Cranial Venous Circulation." By J. SYMINGTON, M.B., C.M.
4. "A Comparative Note upon the Common Buzzard (*Buteo vulgaris*) and the Honey Buzzard (*Pernis apivorus*); with exhibition of specimens. By J. M. ANDERSON. The Honey Buzzard, which was an adult male, and whose stomach contained the remains of a young grouse, was shot at Kilconquhar, Fife, 10th July 1881.
5. "On the Morphology of the Cell," Part II. By PATRICK GEDDES, F.R.S.E.
6. "On the Birds of Glen Urquhart, Inverness-shire." By ARCHIBALD CRAIG, Jun.
7. The SECRETARY exhibited a specimen of the Shore Lark (*Alauda alpestris*), shot at Tynefield, East Lothian, in the winter of 1879.
8. Mr J. SADLER reported that the well-known Sea Anemone, which belonged to the late Sir J. Graham Dalziel, had recently produced seven young ones.

Wednesday, 19*th April* 1882.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: James Barclay Murdoch; Professor A. Stanley Butler; Henry Seebohm, F.L.S.; George Andrew, S.S.C.; John Edward Dovey, C.A.; Edward Bidwell.

The following communications were read:

1. "Notes on the Natural History of Madagascar." By Rev. W. DEANS COWAN.
2. "On the Fructification of *Sphenopteris tenella* (Brong.) and *Sphenopteris microcarpa* (Lesq.). By ROBERT KIDSTON.
3. Dr TRAQUAIR exhibited, with remarks, specimens of *Phronima sedentaria* (Forsk).
4. Mr CAPPER exhibited a specimen of *Trochilus moschitus* and its Nest, which had been forwarded to him through the medium of the post by a correspondent in Jamaica.
5. The SECRETARY drew the attention of the meeting to a pair of young Emus (*Dromaius Novæ-Hollandiæ*), which had been hatched in confinement in Midlothian.

SESSION CXII.

Wednesday, 15th November 1882.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society; Alexander R. Coldstream, M.D.; W. J. Nicol, M.A., B.Sc.; James Gordon Mason, S.S.C.; Robert Wallace.

The following communications were read:

1. Introductory Remarks by Dr TRAQUAIR, President. Dr TRAQUAIR stated that Professor Archibald Geikie, the retiring President, had not been able to undertake to deliver the usual Opening Address at this Meeting, but that arrangements had been made for his doing so before the close of the present Session.
2. "Obituary Notice of the late Sir C. Wyville Thomson, F.R.S." By GEORGE LESLIE, M.B., C.M.
3. "Notes on some Ethnographical Specimens brought from the Nicobar Islands by Colonel Cadell, V.C., Chief Commissioner of the Andaman and Nicobar Islands." By ALEXANDER GALLETLY.
4. Mr GEDDES exhibited, with remarks, a specimen of the Poisonous Lizard (*Heloderma horrida*).
5. Mr GIBSON exhibited a light cream-coloured variety of the Common Thrush, which had been shot at Ardnamurchan Point on 27th September last, and was now in the Collection of Mr J. J. Dalgleish, a Fellow of the Society.

Wednesday, 20th December 1882.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following Office-Bearers were elected:

Presidents—Professor H. A. NICHOLSON, M.D.; R. H. TRAQUAIR, M.D., F.R.S.; B. N. PEACH, F.G.S., F.R.S.E.

Secretary—ROBERT GRAY, F.R.S.E. *Assistant-Secretary*—JOHN GIBSON.

Treasurer—CHAS. PRENTICE, C.A., F.R.S.E. *Librarian*—J. T. GRAY, M.A.

Councillors—D. J. Surenne; John Walcot; Professor J. Duns, D.D., F.R.S.E.; T. B. Sprague, M.A.; William Evans; Andrew Wilson; A. C. Stark; Patrick Geddes, F.R.S.E.; F. E. Beddard, B.A.Oxon.; J. Symington, M.B., C.M.; Andrew Moffat; John Hunter, F.C.S.

The following gentlemen were elected Ordinary Fellows of the Society: William Cleaver Woods, M.B., C.M.; Matthew Hay, M.D.

The following communications were read:

1. "On the genus *Ctenodus*." By Dr TRAQUAIR, F.R.S.
2. "Note on the Occurrence of *Lithobius variegatus* (Newp.) in Scotland." By T. D. GIBSON-CARMICHAEL.
3. "Some Notes on the Anatomy of the Myriapoda," Part I. By T. D. GIBSON-CARMICHAEL.
4. "On a New Nematoid Worm." By F. E. BEDDARD, B.A.Oxon.
5. Mr R. GRAY exhibited, with remarks, a specimen of the Pectoral Sandpiper (*Tringa maculata*, Vieill.), shot on the banks of Loch Lomond on

28th November; also a specimen of the Little Gull (*Larus minutus*), shot at North Berwick on 7th November.

6. Mr ANDREW WILSON exhibited, with remarks, two Skulls, showing Abnormal Dentition in the *Carnivora*. In the first specimen, that of a Domestic Cat, the first premolars—which are normally suppressed on both jaws in the gums—are present in the upper jaw,—the second premolars being rather better developed than usual. The second specimen, that of a Common Badger, showed a rudimentary first premolar on the left side of the upper jaw, the extra tooth, lying close to the base of the canine, being almost concealed by the second premolar.

Wednesday, 17th January 1883.—Mr B. N. PEACH, F.G.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: W. W. Robertson; Edward Chamberlayne; James C. Hamilton: R. J. Harvey-Gibson, M.A.; George C. Chisholm, M.A.; John Gray; Daniel Finlayson; Ernest Gibson; George R. Lawson; Francis W. Grant, M.B.; John M'Laren, Gustave Paul Nicolet.

The following communications were read:

1. "On the Occurrence of *Pterygotus* and *Limulus* in the Caithness Flagstones, and on the mode of formation of 'Adam's Plates.'" By B. N. PEACH, F.G.S., etc.
2. Mr SYMINGTON exhibited, with remarks, a specimen of a Cervical Rib in the Human Subject.
3. "On *Sphenopteris crassa* (L. and H.)." By ROBERT KIDSTON.
4. "Notes on Water Supplies of Villages." By J. HUNTER, F.C.S.

Wednesday, 21st February 1883.—Dr TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Alfred Pullar, M.D.; James Macbeth Forbes.

The following communicatious were read:

1. "On River Terracing: its Methods and Results." By HUGH MILLER.
2. "On the Occurrence of Selenium in Sulphuric Acid, and its action upon Paraffin Oils." By J. C. HAMILTON.
3. "On the Separation and Estimation of Selenium." By JOHN HUNTER, F.C.S.
4. "Additional Notes on the Algæ of the Forth." By GEORGE WILLIAM TRAILL. (Communicated by Professor Duns.)
5. "On the Stockdove (*Columba œnas*), with remarks upon its extension of range in Great Britain." By J. A. HARVIE-BROWN, F.Z.S., F.R.S.E.
6. "Note of unusual variety of colours in eggs of *Larus ridibundus* (specimens exhibited). By Dr J. A. SMITH. Mr BIDWELL, at the same time, exhibited some remarkable varieties of the eggs of British Gulls and Terns.

Wednesday, 21st March 1883.—Dr TRAQUAIR, F.R.S., President, in the Chair.

[T]he following gentlemen were elected Ordinary Fellows of the Society: [Germ]an Sims Woodhead, M.D.; Henry Prain; John R. Henderson.

[Th]e following communications were read:

[1. "]Description of a complete Model (exhibited) of the Fish Hatchery at Howietoun, prepared, at Sir James Gibson Maitland's request, for the International Fisheries Exhibition." By ALEXANDER GALLETLY.

[2.]"Note on Abnormal Dentition in a Frugivorous Bat—Gemination." (Specimen exhibited.) By ANDREW WILSON, L.D.S. In the specimen exhibited (a *Pteropus* from Burmah), a *third* incisor was present on the left side of the upper jaw, and there was the additional peculiarity, that it, and the second incisor, were united. This was the only case he had met with, showing geminated teeth in the lower animals. In man it was rather rare, occurring most frequently in the deciduous set.

[3.] "On a new species of *Octopus*." By W. E. HOYLE, M.A.Oxon. (Communicated by F. E. Beddard, B.A.Oxon.)

[4]. "Notes on *Lepidodendron*, *Ulodendron*, *Sigillaria*, and *Knorria*." (Specimens exhibited.) By ROBERT KIDSTON. "The writer stated that he did not regard *Ulodendron* as a *true* genus, nor yet did it belong entirely to *Lepidodendron*, as some authors seemed to think, but the genus, as used by those who believe in its individuality, included specimens of *Sigillaria* as well as *Lepidodendron*."

[5.] Dr TRAQUAIR exhibited, with remarks, a Bidental Skull of the Narwhal.

6. "On the Occurrence of *Dasypolia Templi* in Midlothian." By WILLIAM EVANS. Mr EVANS exhibited a specimen of this moth, which he had taken at rest on the outside of a window at Merchiston on 11th October last. This species is not mentioned in the list of local Lepidoptera published by Dr Lowe and Mr Logan in 1852, nor in the lists of subsequent captures by these gentlemen and Mr A. Wilson, recorded in the Society's *Proceedings* for 1854, 1857, and 1858; and it is believed the present is the first occasion on which it has been observed in Midlothian. It is known to have occurred at Leadhills.

Wednesday, 18th April 1883.—Mr B. N. PEACH, F.G.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: W. E. HOYLE, M.A.Oxon.; W. A. Bryson; Malcolm Dunn.

The following communications were read:

1. "Note on a Skeleton of the extinct Solitaire (*Pezophaps solitaria*, Gm.) lately added to the Museum of Science and Art." By R. H. TRAQUAIR, M.D.
2. "On a hitherto unrecorded specimen of the Great Auk (*Alca impennis*, L.) belonging to the Duke of Roxburghe." (Stuffed specimen exhibited.) By JOHN GIBSON.

3. "Note on the Glaciated Summit of Allermuir, Pentlands;" with exhibition of rock specimens showing striation. By JAMES BENNIE.
4. "On a Remarkable Injury to the Wing of a Carrion Crow (*Corvus corone*)." By Dr TRAQUAIR, F.R.S. (Specimen exhibited.)
5. "On some Stone Implements from the Mull of Galloway." By Dr GEMMILL, Drummore. (Communicated by A. Macconochie.)
6. Mr J. HARVIE-BROWN exhibited a specimen of the Ivory Gull shot in Roxburghshire on 9th March last. Mr Harvie-Brown read the following remarks, communicated to him by Mr ANDREW BROTHERSTON, Kelso: "As there would appear to be two species passing under the name of Ivory Gull—namely, *Pagophila eburnea* and *P. brachytarsus* *—and as I have not access to full enough descriptions to enable me to judge as to which of the two this example belongs, I took the opportunity of bringing it with me for the purpose of identification. The relative length of the wings and *tarsi* appear to be the chief points of difference. The dimensions of this specimen when fresh were: Length from bill to end of tail, 18½ in.; do. to tip of wings, 20½ in. (that is, 2 in. beyond tail); expanse of wings, 3 ft. 6 in.; wing from flexure, 13⅝ in.; tarsus, 1⅝ in. This specimen, which is a male, was shot at Cessford, in Roxburghshire (nearly thirty miles inland), on 9th March 1883, by Mr W. Barr Scott. When first seen, it was feeding on the carcase of a sheep, on which it had completely gorged itself, being full to the throat when I received it. I may mention that, although Mr Scott is making a collection of birds for himself, he has very kindly presented it to the Kelso Museum, which is a great acquisition to that institution; as, so far as I am aware, it is the only one that has been obtained on the eastern Borders."

* Proc. Roy. Phys. Soc., vol. ii., p. 57.

DONATIONS AND ADDITIONS

TO

LIBRARY OF THE ROYAL PHYSICAL SOCIETY

DURING SESSIONS 1881-82.

Proceedings of the Royal Society [of London], Vols. 32-34, Nos. 213-223. *From the Society.*

Transactions of the Manchester Geological Society, Vol. 16, Parts 4-18; Vol. 17, Parts 1-5. *From the Society.*

Proceedings of the Geologists' Association [of London], Vol. 7, Parts 1-7; Vol. 8, Part 1. *From the Association.*

Transactions of the Zoological Society of London, Vol. 2, Parts 5-7. *From the Society.*

Proceedings of the Zoological Society of London for 1881, Parts 1-4; for 1882, Parts 1-3. *From the Society.*

Proceedings of the Academy of Sciences of Philadelphia for 1880, Parts 1-3; for 1881, Parts 1-3. *From the Academy.*

Annales de l'Observatoire de Moscou, Vol. 8. *From the Imperial Academy of Sciences, St Petersburg.*

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Proceedings of the Royal Society of Edinburgh, Vol. 11, No. 108. *From the Society.*

Transactions of the Royal Society of Edinburgh, Vol. 30, Part 1. *From the Society.*

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A Monograph of the British Phytophagous Hymenoptera, Vol. 1. By Peter Cameron. *Purchased from the Ray Society.*

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*Proceedings of the Literary and Philosophical Society of Manchester, Vols. 11-14. *From the Society.*

*Transactions of the Zoological Society of London, Vol. 4, Parts 1-6; Vol. 5, Part 3; Vol. 10, Part 4. *From the Society.*

*Transactions of the Manchester Zoological Society, Vol. 13, Parts, 1, 2, 4. *From the Society.*

*Transactions of the Royal Scottish Society of Arts, Vol. 3, Parts 1-5; Vol. 4, Parts 1-4; Vol. 5, Parts 1-4; Vol. 6, Part 1; Vol. 8, Part 1. *From the Society.*

*Proceedings of the Philosophical Society of Glasgow, Vol. 6, Nos. 1-3; Vol. 7, Nos. 1, 2; Vol. 10, No. 2. *From the Society.*

*Proceedings of the Natural History Society of Glasgow, Vol. 2, Part 2; Vol. 3, Parts 1-3; Vol. 4, Part 2. *From the Society.*

*Proceedings of the Geologists' Association, Vol. 7, No. 4. *From the Association.*

Donations marked (*) have been presented to the Society to complete its sets of "Proceedings."

LIST OF FELLOWS.

ORDINARY.

Date of Election.

1883. Adam, Alexander, 6 Windsor Street.
1856. Anderson, John, M.D., F.R.S., Director of the Indian Museum, Calcutta.
1880. Anderson, James M., S.S.C., 1 Blackford Road.
1882. Andrew, George, S.S.C., 19 Magdala Crescent.
1882. Armour, Henry, 77 George Street.
1846. Balfour, Professor J. H., Inverleith House.
1849. Barbour, G. F., of Bonskeid, 11 George Square.
1880. Barron, H. J., 7 Montague Street.
1878. Beattie, William Hamilton, 68 George Street.
1884. Beaumont, Alfred, Low Valleyfield House, Culross.
1880. Beddard, Frank E., M.A.Oxon., 32 Queen Street.
1880. Begg, F. Faithful, 12 George Square.
1875. Bennie, James, Geological Survey Office, George IV. Bridge.
1881. Berry, William, of Tayfield, Newport, Fife.
1882. Bidwell, Edward, 1 Trig Lane, Upper Thames Street, London.
1880. Bird, George, 15 West Thirlestane Road.
1883. Black, Alex. M. B., 8 Clarence Street.
1880. Bloxsom, William Gibson, 10 Napier Road.
1883. Bowie, A. F., 16 Duncan Street, Newington.
1860. Brown, Robert, M.A., Ph.D., F.L.S., Fersley, Rydal Road, Streatham, London, S.W.
1876. Brown, J. A. Harvie-, Dunipace House, Larbert.
1876. Bruce, W. P., Kinleith Mill, Currie.
1883. Bryson, W. A., 20 Lomond Road, Trinity.
1878. Buchanan, J. Hamilton, 32 Stafford Street.
1882. Butler, Professor A. Stanley, St Andrews.
1881. Cadell, H. Moubray, 12 Douglas Crescent.
1880. Caldwell, W. H., Caius College, Cambridge.
1878. Cameron, John, S.S.C., 8 Castle Street.
1878. Campbell, R. Vary, 37 Moray Place.
1880. Campbell, Walter, L.D.S., 27 Tay Street, Dundee.
1881. Capper, J. J., Beaufort Road.
1877. Carmichael, Sir W. H. Gibson-, Bart., Castlecraig, Dolphinton.

Date of Election.

1876. Carmichael, Thomas D. Gibson-, Castlecraig, Dolphinton.
1858. Carruthers, William, F.R.S., British Museum, London.
1880. Carter, W. A., M.I.C.E., 5 St Andrew Square.
Carter, J. T., West Medical School, Glasgow.
1883. Chamberlayne, Edward, 47 Great King Street.
1881. Christie, William, Junior, Craigend Park, Liberton.
1883. Clemow, A. H. W., M.B., Royal Infirmary.
1879. Coates, Henry, Pitcullen House, Perth.
1853. Cobbold, Spencer, M.D., F.R.S., London.
1881. Cook, Charles, W.S., 11 Great King Street.
1878. Cornillon, Hypolite W., S.S.C., 130 George Street.
1882. Cowan, Rev. W. Deans, Eskbank.
1883. Cowper, John, 9 Merchiston Avenue.
1881. Craig, Archibald, Jun., 16 Blacket Place.
1874. Crawford, W. C., Lockharton Gardens, Slateford.
1882. Crockett, Samuel, Castle-Douglas.
1850. Crole, David, 1 Royal Circus.
1884. Cumming, W. J. H., 3 Brandon Street.
1884. Cunningham, J. T., B.A., Edinburgh University.
1877. Dalgleish, John J., 8 Athole Creseent.
1879. Daniell, Alfred, M.A., B.Sc., 40 Gillespie Crescent.
1880. Denton, A., M.D., San Marcus, Texas, United States.
1883. Dickson, G. W., M.B., Dunkeld.
1882. Dovey, J. E., C.A., 63 Hanover Street.
1876. Drinkwater, T. W., L.R.C.S.E., Laboratory, Marshall Street.
1880. Drummond, James, C.A., 27 Ann Street.
1880. Drummond, William, S.S.C., 4 Learmonth Terrace.
1883. Dunn, Malcolm, Dalkeith Palace Gardens.
1864. Duns, Rev. Professor, D.D., F.R.S.E., 14 Greenhill Place.
1863. Edmonston, Alexander, 5 Rosendale Villas, Herne Hill, London.
1880. Erskine, William, Oaklands, Trinity.
1877. Etheridge, Robert, Jun., F.G.S., British Museum, London.
1880. Evans, William, 2 Merchiston Bank Terrace.
1883. Ewart, Professor Cossar, F.R.S.E., Edinburgh University.
1884. Ferguson, James E. A., 13 Grove Street.
1882. Ferguson, J., 18 Clyde Street.
1874. Ferguson, William, of Kinmundy, 41 Manor Place.
1883. Finlayson, D., 1 Broughton Place.
1883. Forbes, J. M., 23 Howe Street.
1883. Fraser, Charles, 13 Greenhill Place.
1877. Galletly, Alexander, Museum of Science and Art.
1880. Geddes, Patrick, F.R.S.E., 81A Princes Street.
1884. Geikie, Professor, James, F.R.S., University of Edinburgh.
1883. Gemmill, William, M.B., Drummore, by Stranraer.
1877. Gibb, Philip B., M.A., 14 Picardy Place.
1883. Gibson, E., 17 Mayfield Gardens.
1869. Gibson, John, 11 Melville Terrace.
1881. Gibson, John, Ph.D., F.R.S.E., Edinburgh University.

Date of Election.

1883. Gibson, R. J. H., M.A., 3 Orient Terrace, Liscard, Cheshire.
1880. Glover, John, S.S.C., 1 Hill Street.
1881. Grant, Allan E., 13 Spottiswoode Street.
1883. Grant, F. W., M.B., Barnard Castle, County Durham.
1878. Gray, Archibald, Bank of Scotland House, Bank Street.
1883. Gray, John, Murrayville, Dalkeith.
1874. Gray, Robert, F.R.S.E., Bank of Scotland House, Bank Street.
1878. Gray, J. Train, M.A., 21 Tantallon Place.
1828. Grieve, David, F.R.S.E., Lockharton Gardens, Slateford.
1877. Grieve, Somerville, Salisbury View, Dalkeith Road.
Hallen, J. H. B., 1 Lauriston Gardens.
1883. Hamilton, J. C., Trinity Lodge, Trinity.
1881. Hamilton, Robert, Trinity Lodge, Trinity.
1883. Hare, A. W., M.B., C.M., 59 Forrest Road.
1882. Hay, Matthew, M.D., 12 Hope Street.
1883. Henderson, J., East Elrington, Haydon Bridge.
1883. Henderson, J. R., 1 George Square.
1883. Hepburn, D., M.B., Edinburgh University.
1871. Herbert, A. B., 19 Strathearn Road.
1879. Herdman, Professor W. A., University College, Liverpool.
1882. Hird, T. A., Ford Street, Coventry.
1882. Hogg, Andrew, 33 George Street.
1858. Home, D. Milne-, LL.D., F.R.S.E., York Place.
1878. Horne, John, F.G.S., Geological Survey Office, George IV. Bridge.
1881. Horsely, R. E., Australian Club, Chambers Street.
1883. Hoyle, W. E., M.A., F.R.S.E., 8 Kilmaurs Road.
1881. Humphrey, R., 15 London Street.
1880. Hunter, James, F.R.C.S.E., Craigmillar Villas.
1874. Hunter, John, F.C.S., Minto House, Chambers Street.
1878. Hunter, John, LL.D., Daleville, Braidwood, Lanarkshire.
1883. Jackson, J. E., The Headlands, Horsforth, Leeds.
1850. Jenner, Charles, Duddingston.
1877. Joass, C. Edward, 1 Rankeillor Street.
1884. Johnston, George, 2 Viewforth Place.
1880. Johnston, George H., 9 Claremont Crescent.
1880. Johnston, J. A., 2 Tait Street, Easter Road.
1881. Kemp, D. W., Ivy Lodge, Trinity.
1883. Kennedy, Charles, M.B., 8 St Andrew's Terrace.
1869. Kennedy, Rev. James, M.A., 36 Gillespie Crescent.
1878. Kidston, Robert, F.G.S., Victoria Place, Stirling.
Kilpatrick, H. Grainger, 104 South Bridge.
1869. King, J. Falconer, F.C.S., Chambers Street.
1879. Kirke, D. J. B., Greenmount, Burntisland.
1858. Laidlay, J. W., of Seacliff, 2 Moray Place.
1880. Laughton, William, Mugie Moss Mill, Auchmill, near Aberdeen.
1881. Laurie, A. P., Nairne Lodge, Duddingston.
1884. Laurie, Malcolm, Nairne Lodge, Duddingston.
1883. Lawson, G. R., Banker, Golspie.

Date of Election.

1880. Leck, Henry, Hollybush, Ayr.
1879. Leslie, Dr George, Falkirk.
1883. Lindsay, D., M.B., C.M., 2 Inverleith Terrace.
1884. Lindsay, Robert, Curator of Royal Botanic Garden.
1861. Logan, Alexander, Register House.
1850. Logan, R. F., Spylaw House, Colinton.
1881. Lumsden, J., of Arden, Alexandria, N.B.
1870. Lyon, F. W., M.D., 5 North Charlotte Street.
1855. Macadam, Dr Stevenson, Surgeons' Hall.
1881. Macalpine, A. N., Minto House.
1878. Macconochie, A., Geological Survey Office, George IV. Bridge.
1882. Macdonald, W. R., 1 Forres Street.
1882. Macdonald, L. Mackinnon, Skaebost, Skye.
1879. Mackay, James S., 8 Clarence Street.
1878. Mackay, James F., 81A Princes Street.
1878. Maclaren, W. A., 8 Blackford Road.
1881. Maclaren, James, L.R.C.S.E., Asylum, Larbert.
1883. Maclaren, John, Pentland, Loanhead.
1878. Maclachlan, John, Albert Institute, Dundee.
1884. Macpherson, Rev. H. A., 3 St James Road, Carlisle.
1882. MacVean, Colin Alexander, C.E., 42 Belmont Gardens, Glasgow.
1880. Marsden, R. Sydney, 14 Lothian Road.
1882. Mason, J. Gordon, S.S.C., 8 Henderson Row.
1878. Matheson, Alexander, M.A., 19 Northumberland Street.
1881. Methven, John, 6 Bellevue Crescent.
1881. Miller, Hugh, Geological Survey Office, George IV. Bridge.
1873. Miller, R. K., 4 Bonnington Terrace.
1883. Mitchell, Robert, 14 Marchhall Road.
1876. Moffat, Andrew, 320 Leith Walk.
1876. Moinet, Francis, M.D., 13 Alva Street.
1880. Muirhead, George, Paxton, Berwick-on-Tweed.
1881. Murdoch, T. Burn, M.B., C.M., St Bride's, Boroughmuirhead.
1882. Murdoch, James Barclay, Langside, Glasgow.
1877. Murray, John, F.R.S.E., 32 Queen Street.
1874. Murray, D. R., M.B., C.M., 41 Albany Street, Leith.
1880. Nicholson, Professor H. A., Aberdeen.
1882. Nicol, W. J., M.A., B.Sc., Mason College, Birmingham.
1883. Nicolet, Gustave Paul, 1 Merchiston Avenue.
1858. Paterson, Robert, M.D., 32 Charlotte Street, Leith.
1870. Peach, Benjamin N., F.R.S.E., 8 Annandale Street.
1867. Peach, Charles W., A.L.S., 30 Haddington Place.
1880. Pearcey, Fred, 32 Queen Street.
1881. Pottage, John Cooper, 117 Princes Street.
1883. Prain, Henry, 29 Panmure Place.
1877. Prentice, Charles, C.A., 40 Castle Street.
1883. Pullar, Alfred, M.D., 3 East Castle Road, Merchiston.
1879. Pullar, Rufus D., Tayside, Perth.
1881. Ramsay, Captain Wardlaw, Whitehill, Rosewell.

Date of Election.

1882. Rawson, Herbert E., F.Z.S., 7 Cannon Street, London, S.E.
1868. Reid, Rev. J. Brown, Airdrie.
1883. Richardson, Lieut. R. M., 16 Coates Crescent.
1881. Richardson, Thomas, 29 Clarence Street.
1861. Robertson, Thomas, 21 Berners Street, London, W.
1883. Robertson, William W., H.M. Office of Works, Wardie Bank.
1882. Rogers, Rev. Charles, D.D., LL.D., 16 Danube Street.
1880. Rowland, L. L., University, Salem, Oregon, U.S.A.
1882. Seebohm, Henry, F.L.S., F.Z.S., 6 Tenterden Street, Hanover Square, London.
1880. Shaw, Duncan, 9 Heriot Row.
1884. Shaw, T., 41 St Andrew Square.
1883. Sheriff, George, Carronvale, Larbert.
1881. Simpson, R. J. S., M.A., 18 Leven Terrace.
1882. Simpson, James, Edinburgh University.
1869. Skirving, Robert Scot-, 29 Drummond Place.
1878. Smith, James D., 30 Buckingham Terrace.
1880. Sprague, T. Bond, F.R.S.E., 29 Buckingham Terrace.
1880. Stark, Arthur Cowell, 1 Merchiston Avenue.
1882. Stewart, Robert, 8 Athole Place.
1882. Stirling, James, of Garden, Stirlingshire.
1861. Struthers, James, M.D., 22 Charlotte Street, Leith.
1878. Surenne, David John, 6 Warriston Crescent.
1882. Swinburne, John, Eilan Shona, Salen, by Ardgour.
1879. Symington, Johnson, M.B., F.R.S.E., 10 Warrender Park Crescent.
1881. Tanner, Slingsby T., 67 Frederick Street.
1851. Taylor, Andrew, 37 South Clerk Street.
1882. Taylor, David, 7 Union Place.
1878. Thomson, Alexander, 35 Chester Street.
1876. Thomson, Andrew, 13 Inverleith Place.
1876. Thomson, John, 26 Queen Street.
1878. Thomson, Mitchell, 7 Carlton Terrace.
1874. Thomson, Robert, LL.B., 6 Shandwick Place.
1881. Todd, W. Lang, 16 Alva Street.
1859. Traquair, R. H., M.D., F.R.S., Museum of Science and Art.
1858. Turner, Professor William, Edinburgh University.
1862. Waddel, Peter, Claremont Park, Leith.
1874. Walcot, John, 50 Northumberland Street.
1882. Wallace, Robert, Royal Agricultural College, Cirencester.
1878. Watson, George W., 3 Walker Street.
1881. White, John, 34 Manor Place.
1878. White, Thomas, S.S.C., 114 George Street.
1856. Wilson, Andrew, L.D.S., 21 Young Street.
1875. Wilson, Andrew, Ph.D., 118 Gilmore Place.
1882. Wilson, J. L. G., Geological Survey Office, George IV. Bridge.
1883. Wilson, T. D., M.A., West Newington House.
1883. Woodhead, G. S., M.D., 6 Marchhall Crescent.
1882. Woods, W. C., M.B., C.M., Albury, New South Wales, Australia.

Date of Election.

1881. Young, F. W., F.C.S., 2 Airlie Terrace, Dundee.
1882. Young, J., 64 Hereford Road, Bayswater.
1884. Young, Robert, Uphall Oil Works.

NON-RESIDENT.

1864. Belairs, George, Caroline Lodge, Duddingston.
1862. Bethune, Norman, M.D., Toronto, Canada.
1872. Brown, D. J., Glasgow.
1862. Brown, J. Crichton, M.D., London.
1867. Brown, Geo. H. Wilson, Vancouver Island, British Columbia.
1862. Cæsar, Rev. W., D.D., Tranent.
1861. Cameron, A. G. H., Lakefield, Inverness.
Carpenter, W. B., M.D., C.B., 56 Regent Park Road, London, N.W.
Cleghorn, Hugh, M.D., Stravithie, Fife.
Cormack, Sir John Rose, M.D., Paris.
1873. Dally, Frederick, M.D., Wolverhampton.
1864. Davidson, Andrew, M.D., Madagascar.
1868. Davies, A. E., Ph.D., F.C.S., Lowes Moor, Worcester.
1870. Dick, Thomas, Kirknewton.
1858. Drummond, Captain H., India.
1863. Fair, George, M.D., Buenos Ayres.
1863. Galbraith, George L., Loch Tummel Lodge, Pitlochrie.
1859. Grierson, T. B., L.R.C.S.E., Thornhill.
1855. Hector, James, M.D., C.M.G., F.R.S., New Zealand.
1851. Heddle, Professor M. Forster, University of St Andrews.
1849. Hepburn, Archibald, Barwood House, Ramsbottom.
1874. Hitchman, William, M.D., 29 Erskine Street, Liverpool.
1862. Hargitt, Edward, London.
1872. Hoggan, George, M.D., London.
1861. Home, Lieutenant-Colonel George Logan, Edrom, Duns.
1860. Hunter, Rev. Robert, Library of the Royal Historical Society, London
1867. Kennedy, John, M.D., Elie.
1850. Lawson, Professor George, LL.D., Windsor, Nova Scotia.
1861. Logan, Robert, Carluke.
1862. Macnab, Professor W., M.D., F.L.S., Royal College of Science, Dublin.
1858. M'Vicar, Rev. J., D.D., Moffat.
1862. Manson, George W., Bengal Staff Corps.
1849. Melville, Professor A. G., Queen's College, Galway.
1870. Middleton, James, M.D., Strathpeffer.
1871. Paterson, J., M.D., Brazil.
1878. Prentice, Norman, Otago, New Zealand.
1862. Roome, Major Frederick, Bombay.
1856. Sanderson, R. Burdon, M.D., F.R.S., London.
1857. Shields, Robert, Kentish Town, London.
1861. Struthers, Rev. John, Prestonpans.
Swift, Herbert M., Whitehall, London.

Date of Election.
1861. Thomas, F. W. L., Captain, R.N., Trinity.
1861. Thomson, Professor Murray, M.D., Calcutta.
1860. Valentine, Colin S., LL.D., Jeypore.
1861. Wanklyn, Professor J. A., London.
1870. Wilson, Robert, *Standard*, London.
1874. Young, David.

CORRESPONDING.

Andrew, Rev. J., Newbury, Fifeshire.
1875. Coughtrey, Millen, Dunedin, New Zealand.
1858. Duncan, Rev. J., Denholm.
1877. Edward, Thomas, A.L.S., Banff.
1870. Fraser, Rev. Samuel, Melbourne.
1861. Gordon, Rev. G., LL.D., Birnie, Elgin.
1871. Grieve, A. F., Brisbane, Queensland.
1852. Howden, J. C., M.D., Montrose.
1874. Joass, Rev. J. M., Golspie.
1874. Jolly, William, Inspector of Schools.
1879. Lapworth, Professor Charles, F.G.S., Birmingham.
1871. Macdonald, John, S.S.C.
Mushet, David, Gloucester.
1867. Robb, Rev. Alexander, Old Calabar.
1874. Stewart, Rev. Alexander, Ballachulish.

HONORARY.

1857. Boheman, Professor C. H., Royal Academy of Sciences, Sweden.
1857. Chevrolat, Auguste, Paris.
1857. Dohrn, C. A., Stettin.
1857. Fairmairé, Leon, Paris.
1865. Frauenfeld, George Ritter von, Zoological and Botanical Society, Vienna.
1878. Geikie, Archibald, LL.D., F.R.S., Director General of the Geological Survey.
1857. Gerstaecker, A., Berlin.
1857. Guenée, Achille, Chateau-dun.
1857. Javet, Charles, Paris.
1857. Kraatz, G., Berlin.
1865. Kotscky, Dr Theodor, Zoological and Botanical Society, Vienna.
1869. Lütken, Dr Chr., University Museum, Copenhagen.
1857. Lacordaire, Professor Theodore, Liege.
1857. Lenectere, Marquis de Laferte, Tours.
1857. Marseul, L'Abbe de, Paris.
1857. Meneville, Guerin, Paris.
1865. Mannsfeldt, Prince, Colloredo, Vienna.
1858. Motschoulskv, Count Victor, St Petersburg.

Date of Election.	
1857.	Milne-Edwards, A., Paris.
1857.	Macquerys, Emile, Rouen.
1857.	Obert, M., St Petersburg.
1857.	Reiche, M., Paris.
1858.	Schlossberger, Dr, Tubingen.
1857.	Zeller, P. C., Silesia.
1857.	Zetterstedt, J. W., University of Lund, Sweden.

Fellows are requested to intimate change of Address to the Assistant Secretary,
MR GIBSON, 11 MELVILLE TERRACE.

INDEX.

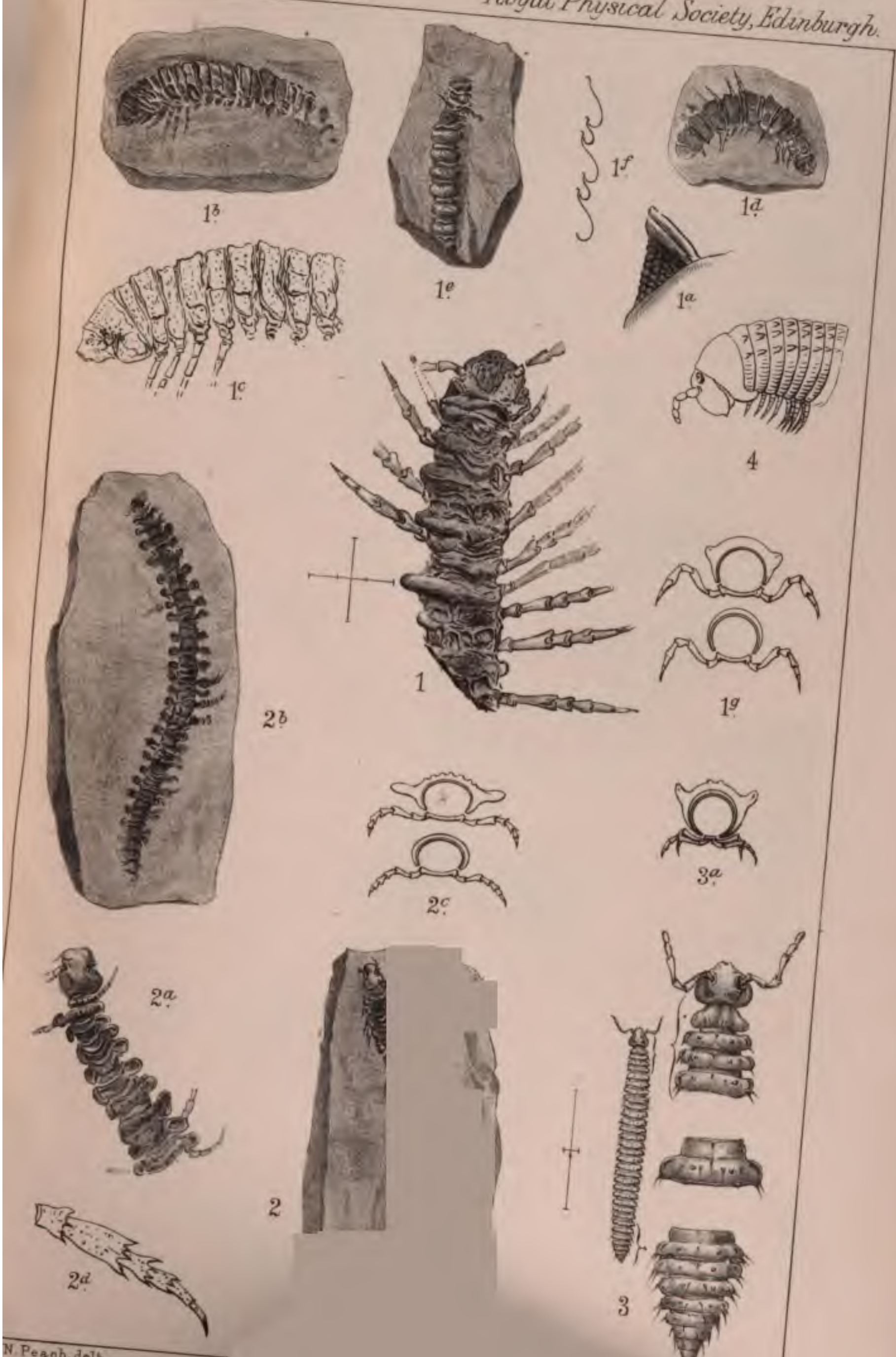
M'Farlane & Erskine, Printers, Edinburgh.

Robt Kidston, del. McFarlane & Erskine, Lithrs, Edinr

Figs. 1–6. Sphenopteris tenella. Brong.
7–14. Sphenopteris microcarpa. Lesq.

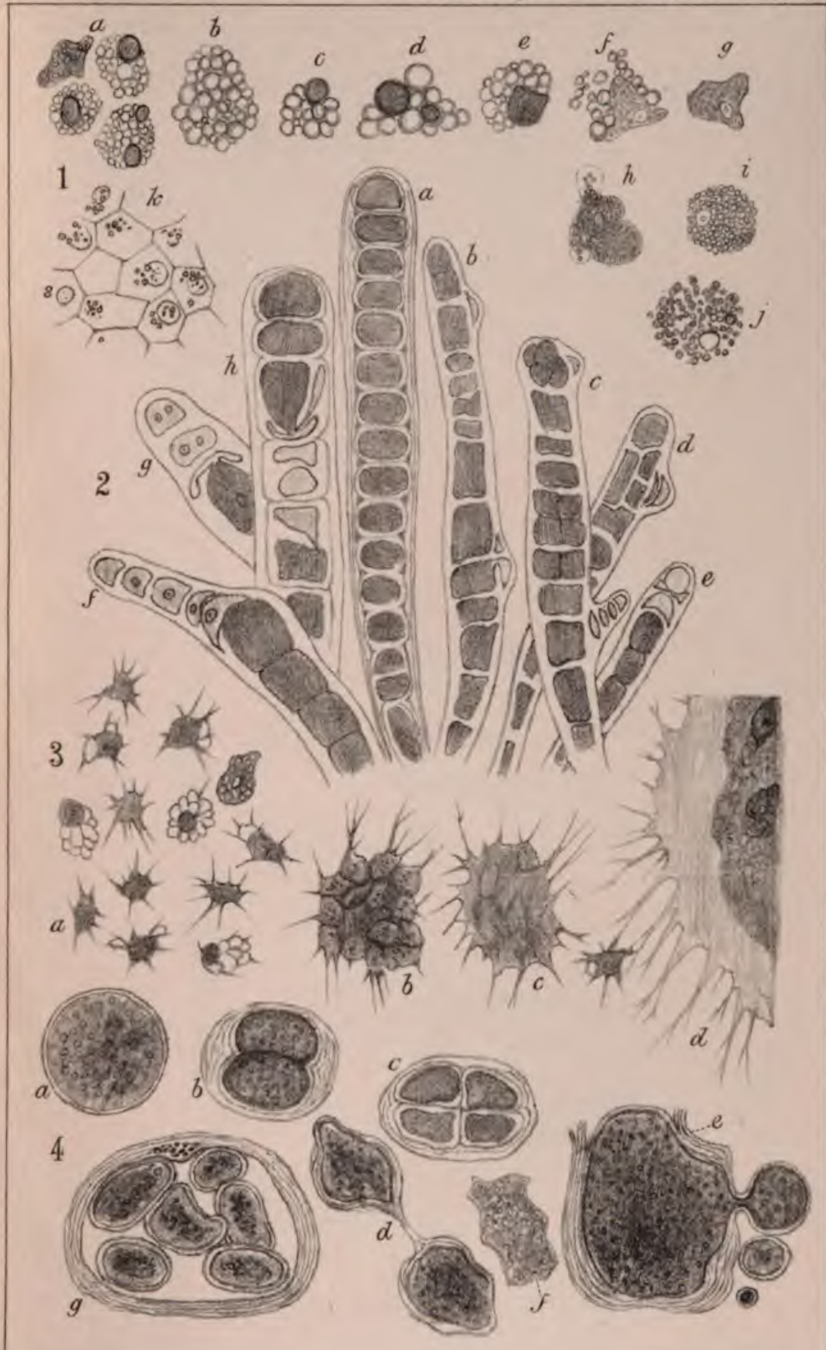
PLATE II.

Royal Physical Society, Edinburgh.



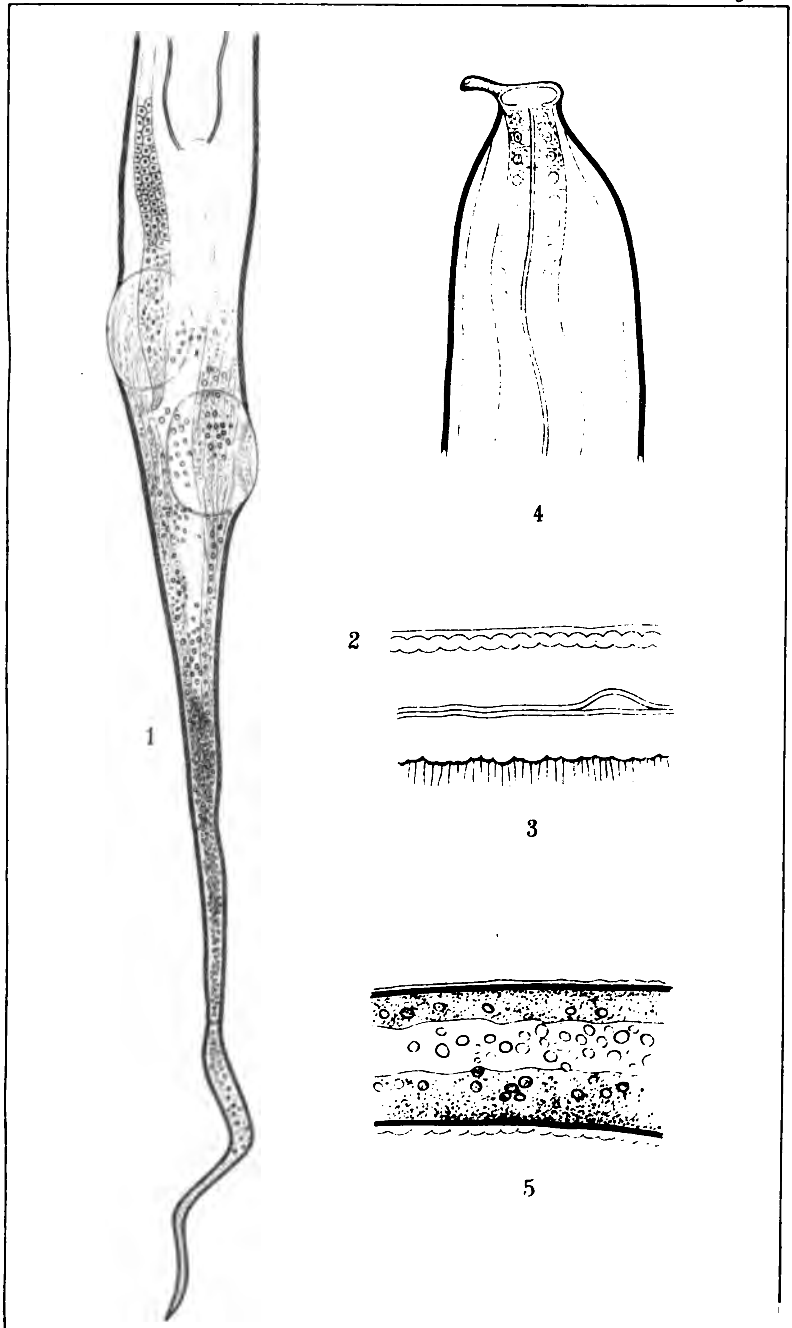
N. Peach, del^t

-L^td Edin^r



P. G. M

P.G. McFarlane & Erskine, Lith.rs Edin.r



F. E. Beddard, ad. nat. del. M^c Farlane & Ers^k

DICELIS PLEUROCHÆTÆ

Fig. 1

Fig. 2.

Robt Kidston, del.

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SPHENOPTERIS CRASSA. L&H.

Fig. 1.

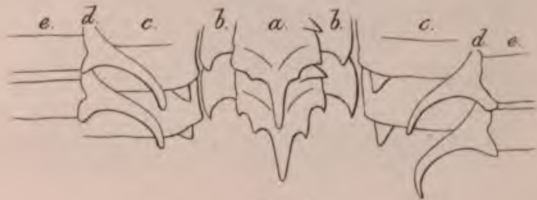

Fig. 4.

Fig. 2.

Fig. 3.

W. E. Hoyle, del. M^c Farlane & Erskine, Lith^rs Edin^r

OCTOPUS MACULOSUS, n. sp.

B. N. Peach, del. M^cFarlane & Erskine, Lith^rs Edin^r

PTERYGOTUS DICKI, ETC.

on